

# **Public procurement and innovation: is defence different?**

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# Abstract

Public procurement is increasingly being studied as a demand-side innovation policy tool, but existing research assumes that defence procurement is different from non-defence public procurement. Defence procurement thus gets sidelined in public procurement and innovation studies. The aim of this thesis is to respond to this gap in knowledge by studying public procurement in military and civilian contexts from different perspectives to understand whether and how defence is different.

At the core of this thesis are three original research articles. The first is a systematic review of the literature on public procurement and innovation, analysing the content of ninety-nine journal articles published between 1976 and 2017. The paper documents the evolution of existing research, highlights dominant and overlooked themes, and characterizes the corpus. The second article applies institutional theory to understand challenges in public procurement. It focusses on words and vocabularies as indicators of institutional logics. Topic modelling of texts related to four procurement projects in the UK (Queen Elizabeth aircraft carriers, Ajax armoured vehicles, railway rolling stock for Thameslink and Intercity Express programmes) shows significant differences in the vocabulary choices of the participants involved in the public procurement process. Vocabulary differences (and, by extension, institutional differences) are more likely to be found in the field of defence than in the field of public transport (the civilian field under study). The third paper investigates public opinion towards major projects and observes changes in public opinion over time for the aforementioned projects. While there are some similarities in the factors that explain periods of positive and negative sentiment, there are some project-specific and sector-specific factors as well. It is also possible to observe the Anna Karenina principle in the relationship between the public and public projects: factors which explain periods of positive or rising public opinion are few in number and common across projects while factors behind periods of negative or falling public opinion are more numerous and sometimes unique.

Studying defence and civilian public procurement comparatively reveals some similarities and some differences. The empirical work shows many assumptions pertaining to defence procurement (like greater public legitimacy and the existence of imperfect markets and complex contracts) to be incorrect or to be found in cases of non-defence procurement as well. It challenges the belief that defence is peculiar. From a management perspective, there is scope for cross-learning and sharing experiences between defence and other sectors of the economy on matters of procurement and innovation. As a research project, this thesis also demonstrates the use of a variety of data sources (journal articles, parliamentary select committee hearings, newspapers) and multiple methods of analysis (text analysis in particular through word co-occurrence networks, topic modelling, and sentiment analysis). This methodological contribution is additionally valuable to the research community.



## Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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# Acknowledgement

In my first supervisory meeting, I was asked whether I had ever failed. I was told that three years is a long time, that the PhD journey is challenging, and that failures would come (they did). If I'm now able to present a thesis and make a bid for the doctorate degree, it is only because I was supported by a phalanx of good and kind people.

My supervisors, Prof Andrew James and Dr John Rigby, created a positive atmosphere for my learning and development. Prof Philippe Laredo, as the independent reviewer at annual progression meetings also provided valuable feedback and encouragement. During a brief period of Andrew's absence, Ms Kate Barker joined the supervisory team and I'm grateful for her support during that time. As a PhD candidate within the Manchester Institute of Innovation Research, I was fortunate to meet many early career researchers who generously shared their own experiences in navigating the world of academia.

Alliance Manchester Business School provided me a studentship for three years (and a further three months on account of Covid-19 extension to study). AMBS also provided an additional research allowance to meet conference fees, travel expenses, and other costs of fieldwork. The PGR office at AMBS administered both and I would like to acknowledge Kristin Trichler and Stefan Johnson for all their support.

A significant part of my research training happened in workshops organised by the Faculty of Humanities (particularly the `methods@manchester` initiative). The Library team at the University of Manchester was enormously helpful. I gained a lot from the writing retreats in particular.

The University was also my home. From my first year, I was part of the ResLife team in the university's Fallowfield campus. I lived in Oak House and then Owens Park as a residential tutor. Senior members of the team like Steph Fisher and Tom Goodison accommodated several demands I made on account of my PhD life. Some of my ResLife colleagues (Yusuf, Anthony, Sarah, Sam) took interest in my work and my well-being, and I'm indebted to them for their time (and tea, and gin).

There is a special bond that is forged between people who undertake the PhD journey contemporaneously in the same school, and it would be remiss of me not to mention "PartyHD" (Olivia, Misha, Eva) and "Heart of Gold" (Sampriti, Mina, Tausif). Nick, with whom I shared office space during the day and a drink in the evening, is perhaps second only to my supervisors in the care and attention he has bestowed on me and my doctoral project since the beginning.

My parents, my brother, and my friends who had known me before I started this journey always reminded me not to let the PhD overwhelm me. They had faith in me when I didn't (and when I called them liars for it, they did not take offence and patiently provided evidence). Without them, I would not have reached this stage.

Oishee Kundu  
Manchester  
5 December 2020

## The Author

In 2012, I joined Saint Stephen's College (Delhi University) for an undergraduate degree in economics. I had obtained a very high score in my school-leaving examinations (some of the highest marks in the country actually) and naturally chose one of the most elite colleges in India for my bachelor's degree.

In the first term, I failed a statistics test and found myself scrabbling on the academic ladder. Other people in my class scored significantly better marks than me and answered questions before I could. Reassuringly, I was not the only one who experienced this – over tentatively forming bonds, I found that most of my new peers had been 'the smartest kid in the school' too and were now feeling that actually they must have been just 'a big fish in a small pond'. However, they became remarkable in other ways, excelling in music, drama, and bird watching, amongst other things. I started tutoring street children in the evenings. I wondered whether this is what happens when you put high-achievers in one field together (they find new fields to excel in), and whether the skewed distribution of exam scores becomes Gaussian over time.

I asked this question to one of my professors after class who encouraged me to develop a research proposal. I suppose at that time research appeared as a self-defence mechanism to me (my CV was not impressing any campus recruitment officer but I was collecting data and creating knowledge which made me feel good about myself). In my third year, I presented a report to the Economics department and received some feedback and praise. Above all, I thought that university and academia could be a place where it was okay if you did not have the best answer as long you had a good *question*.

I graduated in 2015 and chose to pursue a Master's degree at Sciences Po, Paris. The decision was entirely based on the generous scholarships that the school and the French government were providing. In *Les Misérables*, Victor Hugo writes "when one says student, one says Parisian: to study in Paris is to be born in Paris." I was very lucky, very happy, and very busy. I met Prof Andrew James as a student in the 'Political Economy of the Defence Industry' module he taught in the spring term (2016). When the first assignment was returned, I was on the lower end of the Gaussian curve again, but Andrew encouraged everyone in the class to seek feedback. I learnt to improve my work and finished the course with a higher score.

For my master's thesis (mémoire), I was supervised by Dr Jean-Michel Oudot. As a defence economist, he welcomed my questions about India's militarisation. My mémoire on risks in Indian defence procurement was examined by Prof Claude Ménard on 15 May 2017. It won the Prix Bastien Irondele 2017, given by the Association of War and Strategic Studies (AEGES) in France, and the Defence Economics Award in the same year, awarded by the Ministère des Armées.

Andrew read my work and encouraged me to present it at an upcoming conference (the 21<sup>st</sup> Economics and Security Conference in Brussels in June 2017) and share my work more widely (eventually published in *Defence and Peace Economics* in July 2019). And over many meetings in the cafés of Saint-Germain, we discussed another question – was defence procurement different from civilian public procurement?



# Chapter 1

## Introduction

The taxonomy of innovation policy tools discusses public procurement as a demand-side tool for promoting innovation. Despite links between defence procurement and innovation (for example, technological developments based on military requirements have historically contributed to the wider economy), defence procurement is not commonly studied in innovation policy research. Weiss (2014) describes the exclusion of defence in science and technology policy literature as a two-step process: “the state’s role is confined to the defence sector, then that sector is analytically excluded on the assumption that it operates as a self-reproducing enclave, separated from the mainstream economy” (p. 12). Edler and Georghiou (2007) mention the ‘peculiarities’ of the defence sector as a reason for not including defence procurement in their review of public procurement as an innovation policy tool. Their paper remains the most-cited work on the topic and can be found in the highest-ranked innovation studies journal (i.e., *Research Policy*). This PhD project began as a response to their paper’s footnote on the exclusion of defence procurement. The first footnote in the paper goes thus (in-text citations removed):

“There is further consensus in the literature, that military demand in systematic conjunction with military R&D programmes was the key to the development and diffusion of many technologies especially in the US (Internet, many further ICT technologies, Global Positioning System (GPS) and other satellite technologies and – lately – diagnosis and therapy methods within the military project Bioshields). However, the economic efficiency of procurement resting on military needs and only indirectly spilling over to private markets has been strongly challenged. Therefore, and because of the peculiarities of the defence market, defence procurement will not be dealt with in this article.” (p. 950)

According to the footnote, there are two reasons for the exclusion of defence procurement from their review – the dispute over a model of innovation based on military needs and the idiosyncrasies of the defence sector. The latter point is not very specific. The question of peculiarity or uniqueness of the defence sector can be answered from different perspectives – institutional, technical,

contractual, organisational, or legal (to name a few). In this thesis, a few of these perspectives or lenses have been used to study public procurement in the defence and civilian sectors comparatively.

The question – ‘is defence different’ – is important for three reasons. Firstly, the idea that defence is different is so deeply ingrained, not only among procurement and innovation researchers but also in wider public understanding, that it almost appears axiomatic, without requiring any proof. The footnote mentioned above does not elaborate on the ‘peculiarities of the defence market’. Digging deeper into the aphorism of ‘defence is different’ can serve a useful purpose in challenging this axiomatic thinking. In a systematic review of the public procurement and innovation literature which was conducted during this PhD project (described in Chapter 2), it was observed that few researchers who studied defence procurement referred to any distinguishing characteristics of defence procurement. The lack of comment by most researchers could also indicate the axiomatic nature of the statement ‘defence is different’.

Secondly, large and complex public procurement projects exist in both military and non-military contexts. Perhaps there was once a time when procurement of large and technologically complex items was only conducted for military purposes, which could have led to assumptions about the singularity of defence. For example, historical narratives of technology development (like Mowery and Langlois, 1996; Ruttan, 2006; Weiss, 2014) describe the military as the *only* source of demand for complex technologies. Ruttan (2006) suggests that the American system of manufacturing which emerged in the early 19<sup>th</sup> century, involving interchangeable parts and mass production, originated in the military because the Army was the only organisation that could make significant investments to build new factories with new systems (p. 21). The emergence of project management as a discipline can also be traced back to the military programmes prevalent in the USA between the 1940s and 1960s (Johnson, 2013). Perhaps the defence or war department within a government was singular and unique at one point in the scale and complexity of the tasks which it undertook. However, in recent decades, procurement of innovative products and services can be found for non-military purposes as well. The empirical contexts of public procurement and innovation research include a variety of economic sectors and levels of government (Kundu et al., 2020). Understanding the similarities and differences between defence and civilian public procurement could therefore suggest opportunities for shared learning.

Finally, the conjecture that ‘defence is different’ may discourage questions about defence procurement from wider quarters. Such an opinion serves to keep defence in a silo or enclave. It places restrictions on the community which engages with or investigates the topic. There is an argument that discussions on defence require a degree of expertise and that public opinion on defence and security issues are less developed than public opinion on other topics and policy areas (Cohen, 1966; Hartley and Russett, 1992; Eckles and Schaffner, 2011). The belief in defence’s uniqueness is also motivated by recourse to

institutional theory or the distinctiveness of the military as an institution. Organisations, professions, and social systems become institutions through a *process of sanctification* which involves “sentiment-formation” and an “emotional dependence” on symbols that characterise the group (Merton, 1939, p. 565, emphasis in original). An appeal to institutional differences can also deter an examination of the defence sector vis-à-vis a civilian sector of the economy.

Therefore, this thesis addresses the question ‘is defence different’. This chapter aims to provide an introduction to the overarching question posed in the thesis title. The next section discusses key terms and topics of interest and relevance through a literature review. The research framework is then set out, followed by a description of the research context. The final section describes the thesis structure with a schematic diagram providing the outline and contents of the thesis and some comments on knowledge contributions.

## 1.1 Literature review

### Public procurement and innovation

Public procurement refers to the purchase of goods, services, and works by public authorities. It is significant in size, valued at \$11 trillion at a global level in 2018 (Bosio and Djankov, 2020) and constitutes 29.1% of government spending among OECD countries in 2017 (OECD, 2019). Governments around the world and at different levels engage in public procurement to fulfil functions like national security, public health, transportation and mobility, and environmental protection. New technologies and innovations can often help in carrying out these functions in a better manner. The ability to deliver improved public services through innovation procurement, among other reasons, makes public procurement a potential innovation policy instrument (Edler and Georgiou, 2007; Chicot and Matt, 2018).

The ‘other reasons’ encapsulate several strands of economic thought that discuss the role of government in society and the nature or process of innovation, valorising the role of demand in developing and supporting innovation. For example, Marens (2008) discusses the ‘Keynesian’ and ‘Schumpeterian’ functions of government – the former notes the role of public procurement in increasing demand and thus *creating markets* for innovation, while the latter emphasizes public procurement as a means to promote technological change which is important for economic growth<sup>1</sup>. Arrow (1972) discusses the sub-optimal allocation of resources towards innovation because of associated risks. Public procurement can play an important role in the innovation process by absorbing some of these risks and thus increase the investment towards innovation. This is borne out in empirical evidence where greater public procurement is seen to positively and significantly affect firm R&D expenditures (Lichtenberg, 1988;

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<sup>1</sup>Aghion and Howitt (1990) provide a model of economic growth based on innovation and technological development.

Guerzoni and Raiteri, 2015; Slavtchev and Wiederhold, 2016; Caravella and Crespi, 2020). Innovation procurement is also related to the argument that the state is ‘entrepreneurial’ (Mazzucato, 2013), supporting much of the risks associated with new technologies as a ‘lead user’. Additionally, the systems of innovation perspective emphasises the user’s role in articulating requirements and providing feedback in the innovation process, thus positioning public procurement as a critical demand-side innovation policy instrument (Edquist and Hommen, 1999).

The practice of public procurement itself distinguishes between the procurement of standardised goods, services, and simple works on the one hand and the procurement of customised or technologically complex items on the other. In the former case, the accepted practice is to select the lowest priced technically competent bid based on cost efficiency. Theories of auction and competitive bidding are dominant in public procurement (Flynn and Davis, 2014) which justify this orientation towards least cost. However, when procuring non-standardised and technologically complex items, the uncertainty and lack of information (among both buyers and sellers, who have often not yet created the items they would like to sell) leads to a situation where price is not a very useful piece of information. Moreover, the uncertainty and risks of technology development often leads to a situation where any efficiency achieved from selecting the lowest bidder at an early stage can be lost during contract renegotiations at later stages (Tadelis and Bajari, 2006; Chang, 2013). An incomplete contract may be then considered as the optimal solution (Goel, 2001).

## **Procurement as megaprojects**

Procurement that requires innovation, i.e., innovation procurement or ‘public procurement for innovation’, is a more complex transactional activity, involving the invitation of expressions of interest from potential suppliers, pre-bidding conferences and opportunities for clarifications, multiple evaluation criteria, contract negotiation and long-term agreements. Such public procurement activities are often framed as projects – there are specific processes, objectives, and parameters for success, involving managers and a various stakeholders. Procurement projects which are large in size and scope can be referred to as ‘megaprojects’ or ‘major projects’. Megaprojects are defined as “large-scale, complex ventures that typically cost a billion dollars or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people” (Flyvbjerg, 2014, p. 6).

Governments today rarely control the means of production and must engage in a transactional process to procure goods and services necessary to perform public services. In megaprojects, this transactional process is complicated by the presence of technological risks and complex contractual arrangements (Bajari and Tadelis, 2001; Schiele and McCue, 2006). Large projects also have diverse stakeholders and there may be multiple (and sometimes conflicting)



interests involved in a project (Bryson and Bromiley, 1993; Bourne and Walker, 2005; Biesenthal et al., 2018). Procurement can therefore be studied from a project management perspective. The project management literature has a practitioner-focused orientation, similar to the public procurement literature. Additionally, conceptualising procurement at the level of projects is also a simple way of operationalising research concerns, an approach adopted in this thesis, which is further explained in section the next section.

With respect to the question of whether defence is different, it is interesting to find that existing research on megaprojects mentions ‘uniqueness bias’ as “the tendency of planners and managers to see their projects as singular” (Flyvbjerg, 2014, p. 9), and that project managers suffering from ‘uniqueness bias’ are more likely to perform worse in delivering their projects (Budzier and Flyvbjerg, 2013). Thus, the problem of uniqueness bias can be linked to the overarching question of the thesis (‘is defence different?’) because there may be some areas of shared learning between procurement projects from defence and non-defence sectors that could be missed by perceiving defence to be unique or different. Therefore, it is important to investigate what (if any) are the differences between defence and non-defence procurement projects.

## **What is different about defence?**

A number of observations have been made by researchers about defence procurement that differentiate it from other types of procurement. Given the primacy of innovation procurement in this thesis, I have restricted myself to observations made by science, technology, and innovation policy researchers. Since there has not been a concentrated effort towards studying what is different about defence procurement so far, the observations come from a variety of research concerns rather than stemming from an existing theoretical or conceptual framework. Therefore, there was a great degree of flexibility in organising these observations, which played a role in designing the research.

I have organised the observations on defence procurement from the literature into three categories. The first relates to theories of procurement and innovation, where researchers have emphasised the difference in market structures, levels of competition, and the nature of technology development. The second category of observations discusses the practice of defence procurement, focussing on the organisational and institutional environment within which it operates. The third category comprises of observations about the political environment and public opinion.

## **Theories of procurement and innovation**

The most common observation in response to the question of ‘what is different about defence’ relates to the market structure and the lack of competition, making even the study of defence procurement different, requiring different theories. A small number of firms are found on the supply-side selling spe-

cialised products and services to a single customer, and thus the transactions involve very limited competition (Mowery, 2010). Imperfect market conditions necessitate relational contracting, where relations and trust act as a non-market safeguard for enforcing contracts (Mowery and Rosenberg, 1981; Heinrich, 2002). Cost-plus contracts are also mentioned in the literature as a distinguishing feature of the defence market (Rothwell, 1984; Alic, 2007), although it is more widely observed in technology procurement (Goel, 2001) since price is hard to determine for innovation and new technologies, and fixed-price contracts may reduce the incentives of the producer to incur the necessary costs of innovation and technology development. The buyer, therefore, promises to reimburse over and above the cost of development at a later stage.

It is claimed that the products purchased by the military are not subject to market tests in the same way as products intended for civilian use. For example, Alic (2007) points out that weapon systems are only tested in the event of war or conflict, whereas “in the civilian economy, market mechanisms ordinarily reveal poor decisions relatively swiftly” (p. 155). Additionally, the importance of technical superiority in the event of conflict leads governments to procure increasingly technologically complex weapon systems, irrespective of the costs and uncertainties surrounding their use (Dalpé et al., 1992; Weiss, 2014). All these characteristics seem to take military activities outside the realm of market measurements. However, Mowery (2010, p. 1235) also mentions that “measurement difficulty is not unique to national defence” but can also be found in other areas of public mission-oriented spending, like health (see Griliches, 1995).

The existence of technology procurement in health, transport, and other non-defence sectors raises questions on how public procurement and innovation is discussed in different sectoral contexts and whether there are any theoretical or conceptual differences. In addressing the question, it is important to preserve the distinction between public and private procurement activities. In some studies, military procurement is compared to civilian *commercial* procurement, like Alic (2007), which deals with the question ‘what is different about military innovation’. Public procurement for civilian purposes can be in the commercial market, but it can also include procurement of complex product systems which are customised and do not operate in the same markets as commercial products (Walker et al., 1988). Some complex systems intended for non-defence purposes like high-speed trains, telecommunication systems, nuclear power plants, dams for harnessing hydroelectric power are only purchased by public authorities, and are not sold or bought in an open market. Thus, theories of procurement and innovation may be shared on the basis of technical complexity.

## Defence procurement in practice

The idea that defence procurement operates differently from civilian procurement is supported by the existence of different legal systems, procedures, and organisational structures. Procurement researchers are quick to point out a difference in laws and regulations – WTO’s Agreement on Government Procurement (GPA) from its earliest versions has excluded “procurement of arms, ammunition or war materials” or “procurement indispensable for national security or for national defence purposes”<sup>2</sup>. The procurement organisation for defence often includes people from both military and non-military backgrounds, and there could be challenges in cooperation arising from differences in background and training. The military is different from other organisations for the norms, cultures, and logics that it is organised around (Segal and Segal, 1983).

On the supply side, there is an idea about a ‘wall of separation’ between firms. Some researchers claim that military specifications increase the cost and risk for defence contractors, which leads to the separation of defence and civilian production and reduces the possibility of sharing resources (Rothwell, 1994; Markowski et al., 1997). Secrecy constraints imposed by the military establishment also discourage participation from the private sector (Ruttan, 2006), and the few firms which do participate are then seen within the context of a closely-knit and enclaved ‘military-industrial complex’. However, there are arguments and evidence to the contrary as well, demonstrating that many firms operate in both defence and civilian markets, sharing employees, facilities as well as technical knowledge (Hendry, 1989; Mowery and Langlois, 1996; Weiss, 2014; Gholz et al., 2018).

The strategic imperative associated with defence procurement can outweigh many rational considerations, and this may also contribute to the perception of defence procurement operating differently from procurement in other sectors. For example, a 1921 US congressional hearing on war expenditures and procurement repeatedly refers to the neglect of bookkeeping due to military expediency (United States, 1921). From the mid-20<sup>th</sup> century, there is an acknowledgement of the need for economic analysis of defence procurement, as military acquisition went from being a stopgap (e.g., in the world wars) to a large and steady programme of building capacity and enhancing capabilities (e.g., the Cold War) (Miller, 1952). However, as Harvey Sapolsky observes in a 2009 op-ed piece on defence procurement reforms, “when we really want something quickly ... we have to suspend the rules, set up a fast track and push aside the bureaucrats” (Sapolsky, 2009, p. 29). It seems difficult to preserve a systematic procurement strategy in the face of urgent security requirements. Although the recent Covid-19 pandemic has demonstrated that emergency procurement may be required for civilian purposes, one of the reasons for considering defence procurement to be different is this element of critical urgency

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<sup>2</sup>Article VIII in the ‘Tokyo Round Code on Government Procurement’ (1979), Article XXIII in the ‘Agreement on Government Procurement’ (1994), and Article III in the ‘Revised Agreement on Government Procurement’ (2012).

and how that affects the operation of procurement in practice.

### **Political environment or perception**

The final category of observations relates to the politics of procurement, especially regarding public acceptance and public opinion. “Public belief in the legitimacy of the government’s primary mission – defence – smooths the political waters for any related program of government R&D support” (Nelson and Langlois, 1983, p. 816). Researchers have mentioned how the links between procurement and innovation in other policy areas, like environmental protection, have not proved as straightforward as defence (Ruttan, 2006; Mowery, 2012; Alic, 2015). Innovation procurement for defence is able to create a sense of urgency and purpose (and funds) like few other procurement projects can (Edwards, 1997). However, it should be noted that all the researchers cited in this paragraph are/were US academics, looking at the procurement of the US government. Perhaps the idea of the exceptionalism of defence in these works can be attributed to the exceptional circumstances in which the defence sector itself operates in the USA. Other nations may behave differently.

It is also important to account for wider public perception or public opinion. Although there is no study on public opinion or sentiment towards defence *procurement*, there are suggestions that the public knows very little about military policy (Cohen, 1966; Hartley and Russett, 1992; Eckles and Schaffner, 2011). According to Hartley and Russett (1992), national security “represents a realm of policy traditionally regarded as requiring some degree of expert judgment and access to privileged information” and therefore “is a realm best left to those institutionally responsible for the common defense” (p. 905). This thinking often lends support to the smokescreen surrounding defence. Alic (2007) describes how “insiders control the policy debate [in the military arena] and rely on secrecy, appeals to specialized professional knowledge, and obfuscation to get their way” (p. 169).

At the same time, there is some debate over the extent of public ambivalence towards military and foreign policy, as compared to domestic policy. Aldrich et al. (2006) review the literature on foreign affairs and public opinion and find that the public has “reasonably sensible and nuanced views, ... and that these, in turn, help shape and constrain foreign policymaking” (p. 477). Wlezien (1995), observing public opinion on government spending, concludes that “the public is reasonably well-informed about what policymakers do over time in the defense spending domain” (p. 995). This debate in particular makes it exciting to explore the thesis question ‘is defence different’.

## **1.2 Research framework**

The three types of observations about defence procurement – in the domain of theories and concepts (how we study defence procurement and innovation), in the realm of practice (the operational environment of defence procurement),

and in wider public understanding (assumptions about public opinion and social acceptance of defence procurement) – suggest three directions for further study.

## Academic literature

The first direction prompts an examination of the academic literature on public procurement and innovation to understand whether and how innovation procurement is conceptualised for different sectors. Governments procure goods, services, and works to fulfil many functions, some of which are related to defence and security, while other functions fall within the civilian domain. How does the study of public procurement and innovation differ in these different contexts?

A systematic review of existing research on the topic has been undertaken to answer this question. A systematic literature review helps to characterise the literature and can be used to identify theoretical or conceptual differences in the treatment of defence procurement versus civilian procurement in the academic domain. For my project, a systematic literature review is particularly useful for observing the empirical contexts of existing research, noting whether defence procurement was studied, and any references to peculiarities of the defence sector.

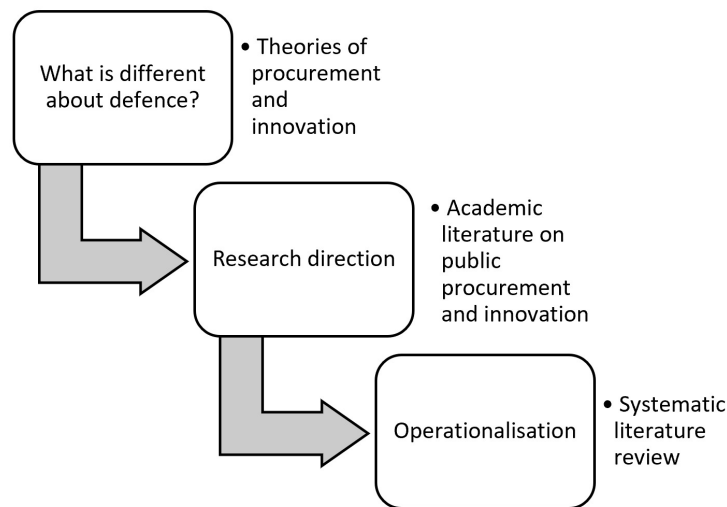


Figure 1.1: Illustrative summary of the first research direction

## Operationalisation

As an exercise, a systematic literature review begins by setting out some inclusion/exclusion criteria on the body of literature or corpus to be examined. I chose to inspect only journal articles published in English and available through the search of large abstract and citation databases like *Web of Science* and *Scopus*. Journal articles are an important format in which researchers

discuss their findings, and the peer-review process acts as an indicator of research quality and acceptance by the academic community. However, such a restriction excludes contributions on the topic available as book chapters, conference proceedings, and ‘grey’ literature. Nevertheless, journal articles can be coded across a variety of variables in line with other systematic literature reviews (like León and Farris, 2011). For my research, the articles were read and coded manually with the help of a coder manual (provided in appendix A.1). The abstracts of all the journal articles were also processed using a semantic analysis software to find word co-occurrences amongst articles and identify research communities within the corpus.

## **Practitioners in the procurement landscape**

The second direction for research draws on the observations regarding the practice or operation of defence procurement. In order to compare practitioners within the defence procurement landscape with those in the non-defence public procurement landscape, an institutional perspective was adopted. Institutional theory provides a strong theoretical basis for understanding the behaviour of individuals in society by referring to ‘institutions’ or ‘institutional logics’ which describe the deeply-held beliefs and logics guiding and justifying behaviour and actions (Thornton and Ocasio, 2008). The institutional perspective is particularly useful for comparative studies because it facilitates the identification of differences as well as similarities between two fields. Some researchers express concerns that institutional theory compels an assumption of similarity by decontextualising individuals and organisations (see Greenwood et al., 2014). Others, like Meyer and Hoellerer (2014), defend the ‘presumption of similarity’ by describing how ‘a certain degree of similarity’ is inherent in the notion of ‘institution’ (i.e., long and deeply held beliefs, values, and norms), and that the explanatory power of institutional theory lies in focussing on similarities and differences between two *distinctive* fields of operation (p. 1229-1230).

## **Operationalisation**

A vocabulary is a system of words used by individuals in an organisation to think and communicate and can thus be an important indicator of institutional logics. Therefore, a research study on the institutional environment can be operationalised by investigating the vocabulary choices of individuals belonging to different organisations. Hearings are a rich source of textual data from a large number of participants (Suddaby and Greenwood, 2005), and for my study, I analysed the transcripts of parliamentary select committee hearings where different stakeholders involved in the procurement process come together to discuss progress, challenges, and provide accountability in a democratic system. The text data was used for topic modelling, an unsupervised machine-assisted text analysis technique that discovers latent topics within a large number of documents (Blei and Lafferty, 2009). Words which occur together are called ‘topics’ and can be labelled manually by the researcher. In

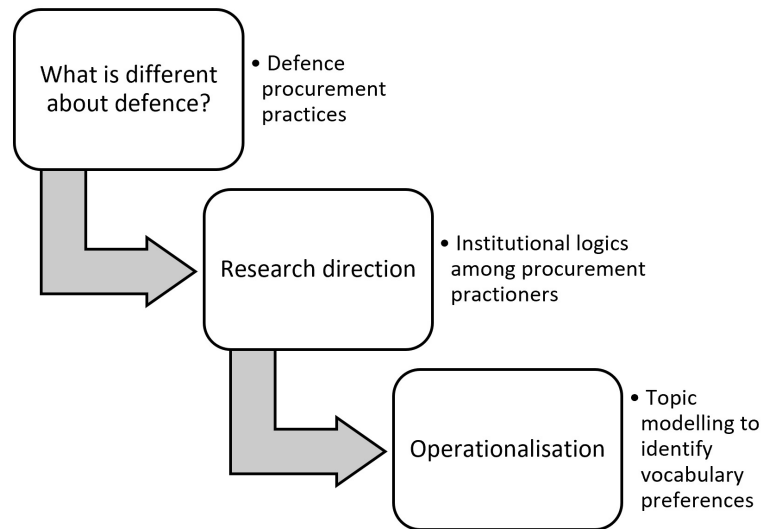


Figure 1.2: Illustrative summary of the second research direction

essence, topic modelling is a quantitative counterpart to thematic coding but is more efficient and allows less researcher subjectivity (Valdez et al., 2018). The topic model can be used for revealing vocabulary preferences of different groups and understand the levels of institutional heterogeneity in the procurement landscape.

## Public opinion

The third direction for examining what is different about defence involves the study of public perceptions about procurement, addressing assumptions about idiosyncrasies of defence which rest on the conjecture that defence and security issues are understood differently by members of the wider public. The literature review reveals a lively debate on whether public opinion on defence and military issues is as well-developed as public opinion on other domestic political issues, with one position arguing along the lines that ‘voters do not care about issues beyond their shore’ (Aldrich et al., 2006). It is also assumed that defence enjoys greater public legitimacy and social acceptance. Do these factors create a privileged political environment for defence procurement?

In order to answer such a question, one needs to study public opinion towards defence procurement alongside public opinion towards non-defence procurement, with a particular focus on whether public opinion changes over the long lifespans of complex procurement projects and what issues cause changes in public opinion. Public opinion can be gauged through surveys, but these are an extremely expensive form of collecting data, and most importantly, may not be appropriate when public sentiment needs to be understood for periods long in the past, a purpose that is better served by analysis of archival data. Several researchers suggest the use of newspapers as an excellent archival source to understand political environments and consider sentiments expressed in news-

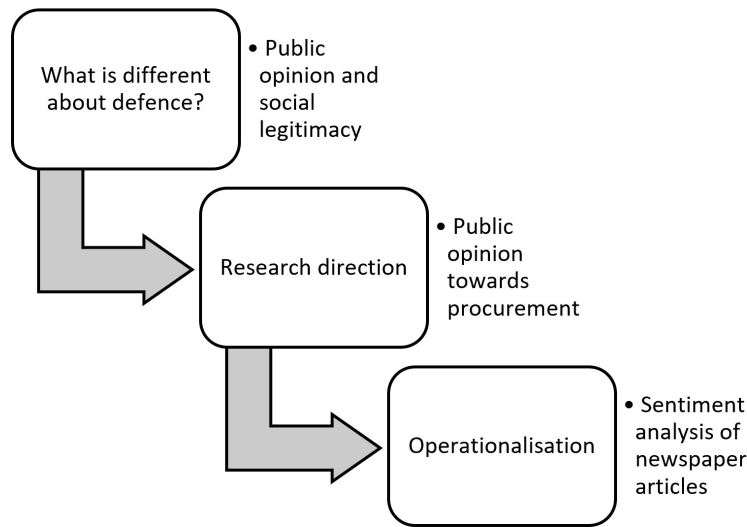


Figure 1.3: Illustrative summary of the third research direction

paper articles as a proxy for public opinion (Mutz and Soss, 1997; Habel, 2012; Edgerly and Thorson, 2020).

### Operationalisation

A text document can be subjected to sentiment analysis, an automated method of giving scores to texts, based on the words within the text and the sentiment expressed (positive, negative, or neutral). I used a software package developed by Rinker (2017) to calculate sentiment scores for the newspaper articles in my study. The software combines a dictionary approach (by looking at the words) with valence shifters to take sentence structure into account (negations like ‘not’, amplifications like ‘very’, ‘really’, de-amplifications like ‘hardly’). The inclusion of valence shifters helps to improve the accuracy of sentiment scores. Although human beings are better than a machine at reading between the lines and interpreting sarcasm and satire that is often used in political contexts, sentiment analysis is a relatively quicker method to analyse text data and has other desirable characteristics like replicability and consistency. Furthermore, as sentiment analysis provides a quantitative output (scores), the scores can be plotted across time, and periods of movement and change in the trajectory of sentiment scores can then be analysed to understand reasons for changes in public opinion.

### Combination of research directions

Overall, the research framework helps address the three categories of assumptions that exist in the literature about defence procurement. It covers three sources or domains in which ideas and knowledge are generated – academia,



practice, and the wider public. The three perspectives can thus be placed in a figurative trinity, suggesting a *plurality* of perspectives within one topic.

The idea of trinity can also be used to suggest *complementarity* of perspectives. For example, the Triple Helix model in innovation studies places universities, industry, and the state at each vertex of the triangle and suggests an innovation system based on the linkages between them (Leydesdorff and Etzkowitz, 1998). In this framework, academics, practitioners, and the wider public are placed at each corner of the triangle. There exist strong links between these three sets of people in knowledge creation on policy issues — academic literature is influenced by the policy work in which practitioners are engaged, the wider public may be guided by academic experts and could also affect the decisions that policymakers take, etc.

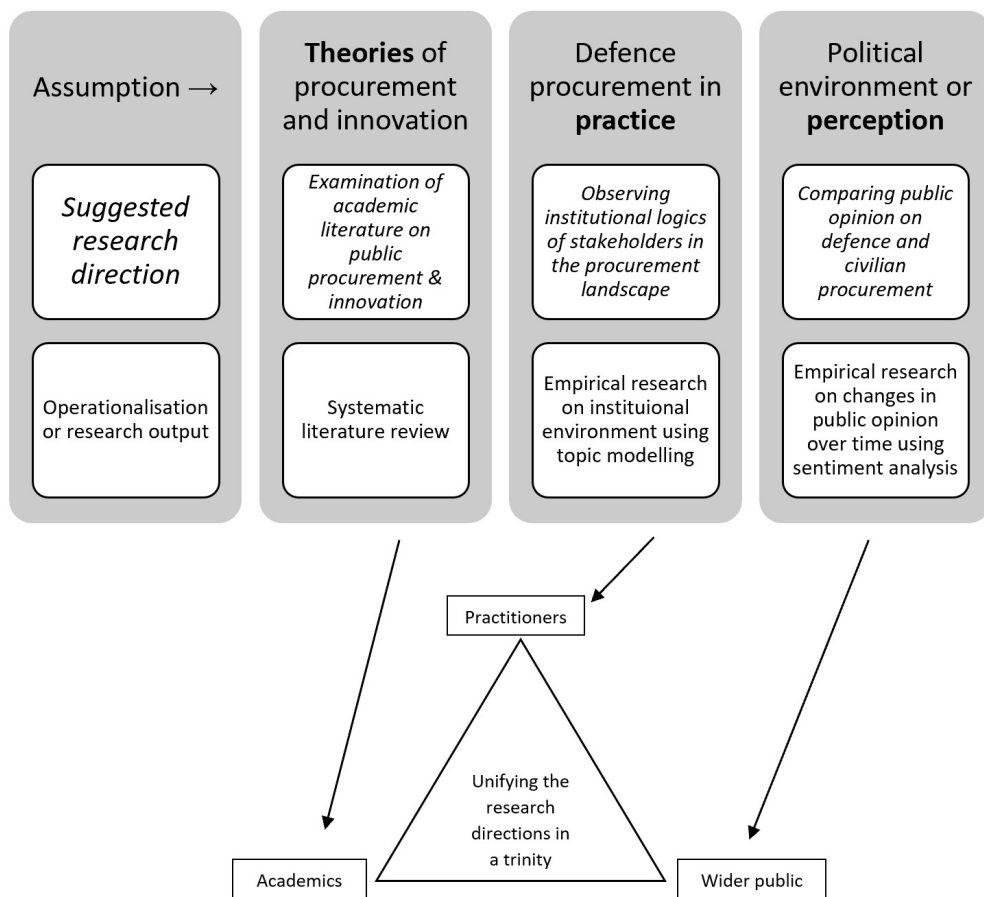


Figure 1.4: Research framework, based on assumptions about what is different about defence

The trinity framework used in this thesis also expresses, in a limited way, an idea of *completeness* by encompassing thoughts (of academics), words (of the general public), and actions or deeds (of practitioners) on the topic of

‘is defence different?’<sup>3</sup> In health research, there exists a theory of the KAP model (Knowledge, Attitude, and Practice) which is used to design surveys and understand diseases that affect a community in a comprehensive manner. The three directions of research pursued in this thesis thus come together in many ways.

This research framework is one possible framework for conducting research on defence procurement to respond to the question ‘is defence different?’ and refers to some structural and institutional properties which characterise a procurement system, like stakeholder management and political considerations. However, it has some limitations. For example, the starting point for constructing the framework is not a broad and general interest in the public procurement exercise but the specific assumptions found in the literature about the peculiarity of defence. Therefore, the framework is not mapped along the lines of a typical procurement process, comparing tenders, contracts, and procurement spending. Furthermore, the research directions are not explicitly linked to the idea of success or “good practice” in public procurement. This is mainly because I did not encounter any claim in the existing literature that defence procurement is different from civilian procurement because it is more (or less) successful in achieving cost, schedule, and technical objectives.

There are alternative topics for empirical research to compare defence and non-defence procurement. These include market structures, relationships between buyers and users, and frequency of innovation procurement. However, time constraints of a PhD project limited my ability to explore more dimensions for comparison and the above framework was used to complete the research with strong theoretical foundations and a reasonable level of comprehensiveness. Additionally, the plural and complementary nature of the three perspectives made this research framework particularly desirable. Nevertheless, I acknowledge and discuss some empirical alternatives and even alternative research frameworks in greater detail in Chapter 6.

### 1.3 Research context

The three research directions are explored with different sources of data and methods. Each direction also examines a different research problem, even as they come together to answer the overarching research question of this thesis. Therefore, the three directions lead to three research papers, and the thesis is structured along the University’s guidelines regarding ‘journal-format thesis’, described in greater detail in the next section. This section discusses the research context, especially the empirical context.

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<sup>3</sup>The three terms – thought, word, and action – are often used together to convey the totality of human experience in different cultures. For example, in Sanskrit, ‘*manasa*’ means thought, ‘*vāchā*’ means word or speech, and ‘*kārmana*’ means action, and the congruence of ‘*kārmana-manasa-vāchā*’ is meant to convey harmony in ancient Indian texts like the *Mahabharata* (Book 13, Chapter 8, Verse 16).

## Studying procurement through projects

The empirical setting of this research is, for the most part, the UK. With the exception of the first paper, which is a literature review and encompasses research work from different countries (albeit limited to publications in the English language), the second and third paper look at four specific procurement projects pursued by the UK government. The projects were selected by systematically reviewing the *Government Major Projects Portfolio*, published annually by the Infrastructure and Projects Authority (the 2017-18 edition was used). The focus on major projects was driven by the assumption that technological complexity and innovation is more likely in such projects.

Four projects – two from the defence sector and two from the civilian sector – were selected, primarily based on their maturity and their procurement component. The choice of projects is more fully explained in Chapter 6 (section 6.2). Both the civilian procurement projects fall under the same department, which makes the work of comparing defence with another sector a little easier. The four projects are described in Table 1.1.

Table 1.1: Selected projects

Project	Department	Description (from GMPP 2018)	Timeline
Queen Elizabeth programme	Ministry of Defence (MoD)	Deliver 2 Queen Elizabeth class aircraft carriers	1998 – 2019
Armoured Cavalry 2025	Ministry of Defence (MoD)	Deliver AJAX armoured fighting vehicle and its training solution into service	1989 – 2019
Intercity Express Programme	Department for Transport (DfT)	Renew the UK’s high-speed train fleet on the Great Western and East Coast	2005 – 2019
Thameslink	Department for Transport (DfT)	A new high-frequency rail service which will increase rail-based capacity in London by 10% and cut journey times across London and the South East	2005 – 2019

The decision to analyse differences between defence and non-defence public procurement through projects is mostly linked to the choices made while developing the research framework. Projects provide a well-defined context within which it is possible to observe both institutional logics (of different project participants or stakeholders) and public opinion over a long period (the development and delivery of projects). In contrast, setting boundaries of study at other analytical levels like industry or technology is much more challenging.

Projects are also an appropriate analytical unit to study technologically complex systems. The manufacturing process associated with such products is project-based rather than industry or firm-based because they require multiple technologies and skills for development (Hobday, 1998, 2000; Davies et al., 2011). Thus, even when comparing procurement activities of government departments, the focus on technologically complex systems suggests the use of

projects rather than organisations as an analytical category. A storyline of the four selected projects is provided below.

## Selected projects

### Queen Elizabeth programme

The 1998 Strategic Defence and Security Review (SDSR) expressed interest in replacing the UK's three Invincible-class aircraft carriers which were approaching the end of their service life with two larger vessels, capable of carrying 50 fixed-wing aircraft and helicopters (Ministry of Defence, 1998, pt. 6, para. 27). Initially called the Future Aircraft Carrier project, the new class of ships was later designated as the Queen Elizabeth-class with two ships – *HMS Queen Elizabeth* and *HMS Prince of Wales*. In January 1999, the Ministry of Defence (MoD) issued the invitation to tender. Two teams led by British Aerospace (now BAE Systems) and Thomson-CSF (now Thales) were awarded contracts in November 1999 to provide competing designs for the new carrier. By January 2001, the US Joint Strike Fighter was chosen as the aircraft to be borne by the carrier, which also informed the aircraft carrier design. The initial plan was to make a choice on the design by 2003, begin manufacturing by the end of the year and introduce the first ship into service in 2012.

Over the course of the project, several decisions were made that caused delays and revisions. For example, in 2003, the MoD began suggesting a different strategy for procurement, where rather than selecting a single supplier, an alliance of both competitors (BAE and Thales) and the MoD would form a partnership called the Aircraft Carrier Alliance (ACA). It took some time to reach an agreement regarding costs and risk-sharing (finalised in 2006). In 2008, the defence budget was reprofiled to meet more urgent requirements and the progress on the aircraft carrier was delayed (manufacturing could only begin in July 2009). The 2010 Strategic Defence Review announced changes in the choice of the aircraft which meant that a different system for take-off and landing would have to be installed on the aircraft carriers (from short take-off and vertical landing system to electromagnetic aircraft launch system). In 2012, the decision on the aircraft was reversed which also affected work on the ships.

From 2012, the Infrastructure and Projects Authority (IPA) began publishing delivery confidence ratings for major government projects. The carrier project had a 'red' rating for the first two years indicating 'successful delivery appears to be unachievable'. Since then, the rating has improved, moving to 'amber-red' in 2015 and 'amber' since 2016 (indicating that successful delivery requires management attention). The first ship of the class (*HMS Queen Elizabeth*) completed sea trials in 2017 and was commissioned in December 2017. Flight trials took place in multiple stages in 2018. The second ship, *HMS Prince of Wales*, was commissioned in December 2019. The ships are expected to achieve full operational capability by 2023.

## Armoured Cavalry 2025

Although the GMPP records the start date of the Armoured Cavalry programme as 2014, the procurement of armoured vehicles for the British Army has a longer history. The Future Family of Light Armoured Vehicles (FFLAV) project was launched in 1989 to procure armoured personnel carrier and armoured vehicles for reconnaissance operations and replace the previous fleet which had been in service since 1971. In May 1992, an initial feasibility study was approved to discuss TRACER, or Tactical Reconnaissance Armoured Combat Equipment Requirement.

A few years later, it appeared that the US had similar requirements, and on 7 July 1998, a Memorandum of Understanding was signed between the US and the UK for procuring the vehicles. However, in October 1999, the US changed its requirements and withdrew funds from the TRACER programme. This led to some instability and the programme was reported as cancelled in the 2002 Major Projects Report. However, by this time, the Ministry of Defence also suggested that “much of the technology development as part of TRACER will be pulled through into the FRES programme” (Defence Committee, 2002, Ev 75). FRES or Future Rapid Effect System was thus the next attempt at replacing the ageing armoured fleet.

Around the same time, the UK became increasingly engaged in the wars in Iraq and Afghanistan and was procuring armoured vehicles under ‘Urgent Operational Requirements’. FRES was therefore pursued in response to a long-term requirement for armoured capacity. Following an Equipment Examination review by the MoD in December 2008, FRES was divided further into FRES SV (Specialist Vehicle) and FRES UV (Utility Vehicle). For FRES SV, the invitation to tender was issued to BAE Systems and General Dynamics UK and GD UK was announced as the preferred bidder on 22 March 2010.

GD completed the preliminary design review in December 2012, which included mobility trials and de-risking the vehicle’s chassis. In 2013, the programme continued into its demonstration phase, undergoing operational and tactical mobility trials, cold weather trails, ease of maintenance assessment, and mine blast trials. In January 2014, the number of vehicles was confirmed, and in September, MoD awarded a £3.5 billion manufacturing contract for 589 Scout Specialist Vehicles. GD, in its turn, signed contracts with several suppliers, including Lockheed Martin, Thales, and GE Intelligent Platforms, for subcomponents like turrets, sighting and computing subsystems.

FRES SV was later subsumed under Armoured Cavalry 2025 and the family of vehicles is now called Ajax. It contains six variants of armoured vehicles in order to provide an integrated multi-role capability to the British Army. In 2015-16 the programme moved to the manufacturing phase – the first 100 platforms were to be assembled and tested in GD’s European Land Systems’ facility in Seville (Spain), and the remaining 489 were to be assembled in a new facility in Merthyr Tydfil in South Wales. Final acceptance delivery and

trials began in 2018 but have faced disruptions and delays in recent years due to technical problems with the vehicles produced and also due to the Covid-19 pandemic. The programme has had an ‘amber’ delivery confidence rating in every IPA report, linked to delays experienced in the demonstration and manufacturing work.

## **Thameslink**

The Thameslink programme aims to provide a high-frequency rail service in London and Southeast England to increase capacity and reduce overcrowding. It involves infrastructure development in stations, along railway tracks, and revised franchising of train services, and a critical aspect of increasing capacity is the procurement of new trains. Although train services are privatised in the UK, the Department for Transport (DfT) is directly involved in the rolling stock procurement for some major orders like Thameslink, Crossrail, and Intercity Express Programme. The arrangement is summarised as one where DfT initiates the procurement process and conducts it on behalf of the train operating company (TOC) who will ultimately operate, maintain, and finance the fleet (Department for Transport, 2008). One of the reasons for the DfT to lead the procurement for Thameslink was that the procured trains would be operating over multiple operating franchises and a single operator might not have the right incentives for procurement (Comptroller and Auditor General, 2014, p. 8).

The Thameslink network was first opened in 1988. The first proposals for expansion and increasing capacity on Thameslink were made in 1989 but this was followed by a major restructuring of the railways (Railways Act in 1993 and 2005), affecting the possibility to make progress on any plans. The programme was later announced in a DfT White Paper in 2007 and the invitation to tender was issued in November 2008. In June 2011, Siemens was announced as the preferred bidder and the contract was awarded in June 2013. On the operational side, a “super franchise” combining Thameslink, Southern, and Great Northern operations was awarded to Govia in 2014.

Infrastructure work on train stations like lengthening platforms and updating the signalling systems also began in 2009 and was completed across the network in different stages. One of the most substantial station works took place in London Bridge between 2013 and 2018. The first of the Siemens-built Class 700 trains entered service in June 2016. When trains began to be introduced, additional work was identified in the wider network for supporting the desired frequency of train services, and there were warnings by the National Audit Office regarding operational challenges if more drivers, signallers and other support staff were not trained (Comptroller and Auditor General, 2017, para. 3.6). Siemens completed the rolling stock order in March 2018. However, the rollout of new trains into service was affected by poorly managed timetable changes in 2018 as well as the pandemic, which disrupted driver training. The project has mostly been rated as ‘amber’ by the Infrastructure and Projects

Authority and is expected to be completed by 2026.

### **Intercity Express Programme**

The Intercity Express Programme (IEP) was launched in 2005 as the Super Express Programme “to examine how the current Intercity 125 High-Speed Trains, introduced between 1976 and 1982 could be replaced” (Department for Transport, 2009, para. 57). The 2007 DfT White Paper ‘Delivering sustainable railways’ emphasised that the fleet of trains purchased under the intercity express programme were intended to be lighter and more environment-friendly for long-distance journeys. The objectives also valorised flexibility – the trains should be readily deployable on different lines, it should be possible to lengthen or shorten them as required, and they should be adaptable to different sources of power.

The 2008 Rolling Stock Strategy published by DfT anticipated the introduction of 90 to 140 full-length trains within IEP. The invitation to tender was issued in November 2007 and bids were received from two consortia – Express Rail Alliance (composed of Bombardier Transportation, Siemens, Angel Trains, and Babcock and Brown) and Agility Trains Limited (comprising of Hitachi, Barclays Private Equity, and John Laing). On 12 February 2009, DfT announced Agility Trains as the selected bidder, but it was only in July 2012 that the contract was finally awarded. The delay is attributed to various factors, including financial challenges due to the European debt crisis, a departmental review of the programme itself (the Foster review in 2010), and changes in requirement.

For example, in the original tender in 2007, bidders were asked to supply three types of trains: electric, diesel, and bi-mode (an electric transformer carriage at one end, a diesel generator carriage at the other). In July 2009, DfT announced that the route from London to Bristol, Cardiff and Swansea (the Great Western Main Line) would be electrified; therefore, wholly diesel trains would not be required. Rather than issuing a new tender and running the competition again, DfT asked Agility Trains to submit a revised bid to supply only electric and bi-mode trains. However, by 2016 it emerged that the route electrification plan was running 18 to 36 months behind schedule. The delay had a knock-on effect on IEP and the type of trains – at that point, a decision was made to procure only bi-mode trains.

Most of the trains were manufactured and assembled in a new facility in Newton Aycliffe in County Durham. The first train was introduced into service in October 2016, and the programme was expected to be completed in the summer of 2020, although the reduction in passenger numbers due to Covid-19 meant that not all the new trains were required for use. The programme has received different delivery confidence ratings over the years, ranging from ‘green’ between 2013 to 2015 to ‘red’ in 2018 due to technical issues leading to delays in the introduction of new trains into service.

## 1.4 Thesis structure

This thesis was developed as a journal-format thesis and the core chapters of the thesis are written in the form of journal articles. The choice between the journal format and a traditional monograph was decided in favour of the former as it allowed greater flexibility in exploring the research question in different directions. Each of the core chapters reflects a research direction within the framework (Fig 1.4). Chapter 2 provides a systematic literature review of the public procurement and innovation literature. Chapter 3 describes the topic modelling work undertaken to study institutional heterogeneity in defence and transport public procurement. Chapter 4 looks at the trajectory of public opinion towards the selected procurement projects and identifies issues which lead to changes in sentiment.

Chapter 5 brings these three papers together along two lines. The first is the complementarity of the papers to each other in a figurative trinity of knowledge, encompassing theory, practice, and perception. Chapter 2 is a literature review and thus concerned with an academic community. Chapter 3 observes practitioners in the procurement process. Chapter 4 delves into public opinion and public perceptions towards procurement projects. Together the chapters form a trilogy or triptych. The second link between the three core chapters is with respect to the commonality in methodology. Each paper emphasises the use of text analysis and seeks different ways to derive meaning from text data. Chapter 5 also consolidates the findings from the three papers and provides a response to the question ‘is defence different’.

Chapter 6 is the final chapter of this thesis. It provides a summary of the thesis and discusses the research strategy in greater detail, including alternative research directions. It also discusses the limitations of the thesis and directions for further research. Figure 1.5 provides a schematic representation of the thesis, linking the different chapters to the research framework.

## Contributions

The three papers make significant contributions to subject knowledge, provide novel methodological insights, and generate new questions for future research. They are original and valuable as independent pieces of research work in themselves. The systematic literature review (Chapter 2) shows the state of the literature on public procurement and innovation and suggests directions for developing it further. The institutional logics paper (Chapter 3) mobilises institutional theory to understand public procurement challenges and provides evidence of the pre-conditions for conflict in the procurement process based on language and vocabulary choices of different participants. The study of public opinion on procurement projects (Chapter 4) identifies factors that characterise positive and negative public opinion and factors that trigger a change in opinion. Together, the three papers form a triptych (elaborated in Chapter 5) which investigates whether and how defence is different from non-defence



public procurement. The thesis makes its mark by addressing an old and controversial question with new methods of analysis.

Over the course of this project, efforts were also made towards contributing to the research and wider community. The first of the three papers was published in *Science and Public Policy* in September 2020. The third paper was submitted to *Public Management Review* and is undergoing revisions suggested by the editor and reviewers. The second paper is being prepared for submission to a relevant journal in the field of operations management. All three papers have been presented at multiple conferences in various formats – as posters<sup>4</sup> and initial drafts<sup>5</sup>, for peer review and feedback. While the publication strategy contributes to knowledge-building by engaging with other researchers in the field, I have also taken the opportunity to present my research to a wider audience. In January and June 2020, I developed and delivered a 7-week course on public procurement, based on my research, to school children under the aegis of *The Brilliant Club*, a UK charity which provides school students with an experience of university-style learning<sup>6</sup>.

This thesis documents the research work relevant to the doctoral project and demonstrates my ability to contribute to knowledge. In the process of doing research and writing the three papers, I was supported by my supervisory team – Prof Andrew James and Dr John Rigby – who are co-authors in all three papers. While the literature review and methodological strategy (data collection and analysis) were always executed independently by myself, it was in the writing of the papers that my supervisory team had to advise me the most. In the first paper, Andrew helped to delineate the findings and conclusions and John provided inputs on the temporal evolution of public procurement and innovation in the world of policymaking.

The amount of direction provided by the supervisory team reduced over the course of the three papers. In the second paper, while the supervisors had been instrumental in suggesting some readings on institutional theory, operationalising the concept of institutional logic by focussing on vocabularies was my idea. For the third paper, I led the framing process, with inputs from supervisors on points of language and presentation of results. John’s reflections on the Anna Karenina principle were particularly helpful.

On the whole, the research presented in this thesis is my work. I am the lead author for the three papers and responsible for the manuscripts (published and otherwise).

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<sup>4</sup>American Political Science Association’s Annual Meeting 2020, Defence and Security Doctoral Symposium 2019 (organised by Cranfield University), Methods Fair at the University of Manchester 2019

<sup>5</sup>Annual conferences of the Comparative Agendas Project (June 2020) and the European Forum for Studies of Policies for Research and Innovation (June 2018)

<sup>6</sup>See <https://thebrilliantclub.org/>

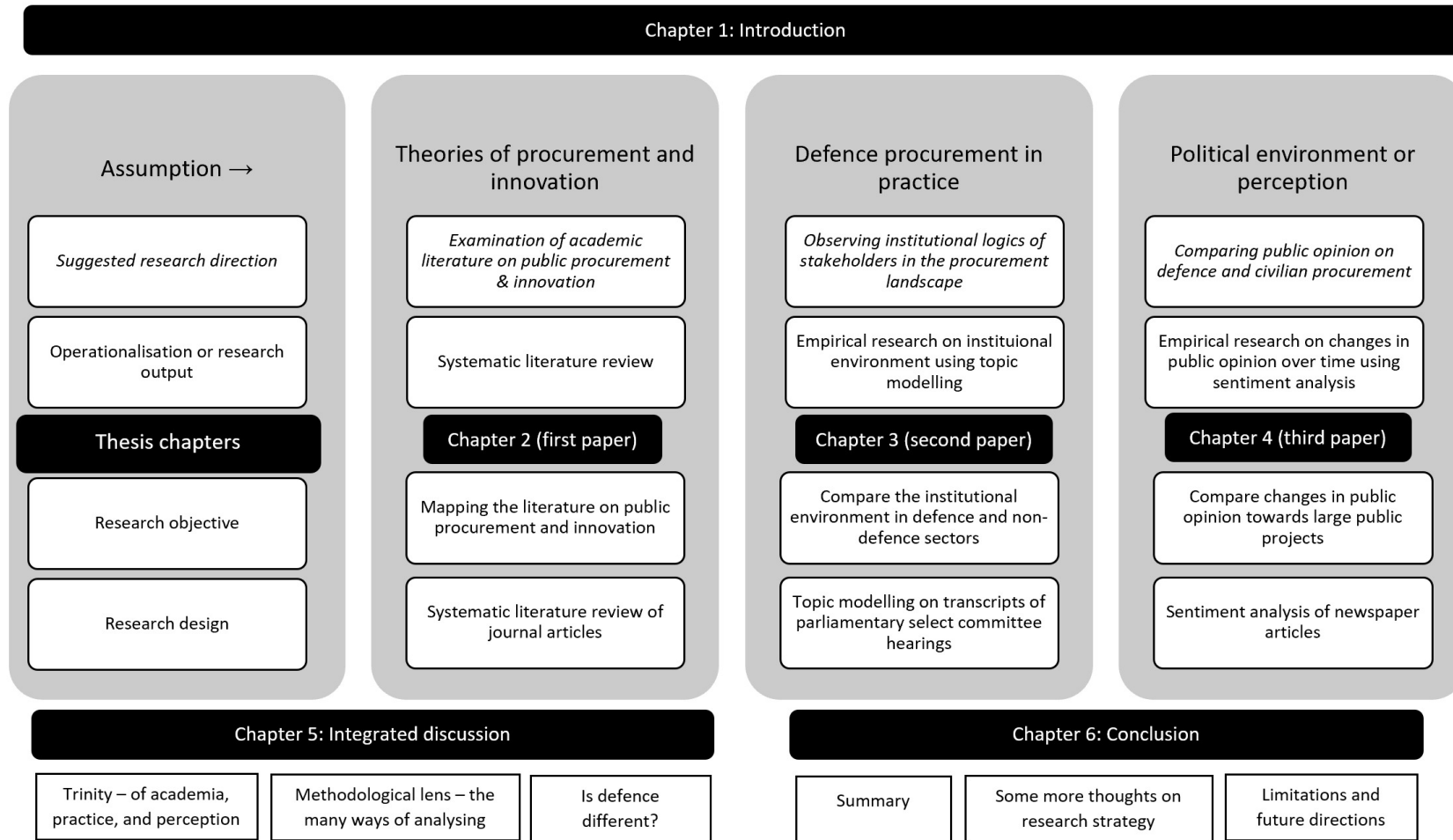


Figure 1.5: Thesis structure

## Chapter 2

# Public procurement and innovation: a systematic literature review

This chapter presents the first of the three papers. The manuscript was submitted to *Science and Public Policy* on 4 August 2019 and accepted for publication on 9 April 2020 (DOI: 10.1093/scipol/scaa029). An earlier draft of this paper was presented at the 2018 EU-SPRI Annual Conference in Paris. The plural pronoun (in this and the two following chapters) refers to myself and my two supervisors, who are co-authors in the publication effort. I am the first author and the corresponding author for each paper.

The starting point of my PhD proposal was the footnote in the Edler and Georghiou (2007) paper and an interest in innovation procurement. Therefore, in the first year of the PhD programme, I conducted a systematic review of the literature on public procurement and innovation. The process and results of the exercise are presented in this chapter. In the first instance, I reproduce the paper as published. However, a journal article has a more limited word count than what is generally allowed in a thesis chapter, and some parts of analysis and text could not be included in the journal submission. These have been included at the end of the chapter. Particularly, the comments on defence research within the innovation procurement literature are not in the journal-version of the paper but the thesis-version of the paper (i.e., this chapter).

### Abstract

Public procurement and innovation is the subject of a growing body of literature. This article systematically reviews the existing research, documenting its evolution and highlighting dominant and overlooked themes. We find a dramatic increase in the number of journal publications on this topic since 2008, the existence of thematic communities within the literature, and a focus on empirical work. We analysed keywords and abstracts to identify the broad boundaries of research on public procurement and innovation as well

as particular areas of focus in the literature. We found a variety of terms used to describe the application of public procurement as an innovation policy tool and a variety of thematic interests and theoretical foundations. We argue that this makes it challenging to consolidate the research on the topic. From a policy perspective, the geographical context of research is overwhelmingly concentrated in OECD and EU countries.

**Keywords** public procurement; innovation; demand-side innovation; public procurement of innovation; systematic literature review

## 2.1 Background

There is a growing body of literature on public procurement and innovation. While there are a number of excellent reviews on this topic (Hommen and Rolfstam, 2009; Lember et al., 2015; Chicot and Matt, 2018), to our knowledge, there has been no systematic review of the literature. Lember et al. (2015) and Chicot and Matt (2018) are specific in their attention to ‘public procurement *of* innovation’, which is defined as “purchasing activities carried out by public agencies that lead to innovation” (Rolfstam, 2013, p. 12). Some studies on public procurement and innovation use the term ‘public procurement *for* innovation’, which is described by Edquist et al. (2015) as “a demand-side innovation policy instrument in the form of an order, placed by a public organisation, for a new or improved product to fulfil its particular needs” (p. 1). There are other papers in the literature that refer to pre-commercial procurement (PCP). PCP is a concept introduced in 2006 by the European Commission, drawing on the example of the US Small Business Innovation Research (SBIR) programme. There has been a debate about whether PCP is a demand-side policy tool in the same sense as public procurement ‘for’ innovation (see Edquist and Zabala-Iturriagoitia 2015).

In order to address these multiple ideas regarding public procurement and innovation, this article systematically collected literature on the topic. The article analyses this corpus to examine the evolution, foundational concepts, methods, and contexts of the research on public procurement and innovation.

Public procurement is commonly understood as the purchase of goods, services, and works by the government in order to perform its functions. The idea that public procurement can be a powerful tool in driving innovation and spurring technological development is based on models of innovation that emphasise the role of demand (Dalpé, 1994; Edquist and Hommen, 1999; Alic, 2008). There is a long history of studies of the demand-side, the role of public procurement in industrial innovation and its influence on the emergence and growth of technology-intensive sectors such as aerospace, computers, semiconductors, and software (Pavitt and Walker, 1976; Rothwell, 1981; Nelson and Langlois, 1983; Ruttan, 2006).

The last two decades have seen growing interest in placing demand at the core of innovation policy (Boon and Edler, 2018). The idea has captured the attention of policymakers for two reasons. Firstly, it reflects the dissatisfaction with supply-side innovation policies amongst policymakers (Edler and Georghiou, 2007). Secondly, using public procurement as an innovation policy tool is considered to be an opportunity for increasing the efficiency of public spending in the economy, especially after the public spending cuts following the 2008 financial crisis. Government spending accounts for 40% to 55% of GDP in most OECD countries, making government procurement a potentially powerful demand-side influence (OECD, 2011).

This article reports the results of a systematic literature review of academic journal papers on public procurement and innovation and public procurement as a demand-side innovation policy tool. A systematic literature review uses rigorous and transparent methods to screen, select, and analyse a body of literature (Boland et al., 2017). The motivation for conducting such an exercise is to map the literature in a manner that identifies key concepts and gaps (Pham et al., 2014)<sup>1</sup>. The findings offer an opportunity for existing researchers in the field to be reflective, and the review also suggests directions for further development of the field.

This article makes three contributions to knowledge. The first contribution is a systematic literature review on public procurement and innovation, a methodologically rigorous process of reviewing existing research on a topic. To our collective knowledge, this is the first systematic literature review on public procurement and innovation. We find this surprising given the academic and policy interest in the topic. Secondly, as a literature review, the article also contributes to a more fine-grained understanding of the characteristics of the literature, including such important matters as the evolution of research interest in the topic and foundational assumptions and methods used over time. Thirdly, the systematic review provides an opportunity to identify key themes in public procurement and innovation research and identify dominant themes as well as under-researched areas.

This article is structured as follows. Section 2.2 describes the methodology used, including the search and selection criteria for building the corpus and the coding procedures. Section 2.3 presents the findings, discussing the evolution of the field, the themes and research questions found in the literature, its theoretical foundations, research foci and contexts. Section 2.4 summarises and concludes.

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<sup>1</sup>Systematic literature reviews are sometimes pursued with the objective of presenting an assessment of an intervention and are called ‘meta-analysis’ or ‘meta-evaluation’. Because such systematic reviews of literature were first done in medical research with the purpose of assessing the effectiveness of clinical interventions, there is often an expectation of systematic reviews to do the same (i.e. report on the effectiveness of intervention). A ‘scoping review’ is therefore the technically correct term for a systematic study of literature that does not conduct a meta-evaluation. However, in the interest of visibility, we have followed the conventional name ‘systematic literature review’ in this article.

## 2.2 Methods

Systematic literature reviews are characterised by a careful recording of the process of searching and selecting items in the literature for review. Such a process helps in improving the replicability and reliability of the literature review. This section describes how the corpus was created and investigated, justifying the choices made when beginning this study.

### Building the corpus

The search was conducted across four large abstract and citation databases of peer-reviewed literature – *Web of Science*, *Scopus*, *Business Source Premier*, and *EconLit*. The Boolean expression ((public OR government) AND (procurement) AND (innovation OR technology)) OR (demand AND side AND innovation AND policy) was searched across abstracts. The inclusion/exclusion criteria for building the corpus were as follows:

*Criterion 1: the item should be a research article published in a peer-reviewed journal and in English*

The restriction to work published in journals was made with the knowledge that despite some criticisms and drawbacks, the peer-review process is the most commonly used method of research validation, and therefore creating a corpus from peer-reviewed work reveals the accepted ideas on the topic. Admittedly, this misses out some of the research present in books, book chapters, and the grey literature. For instance, a number of significant contributions on the topic have been in books or book chapters, including Edquist and Zabala-Iturriagoitia (2012) and Rigby (2016). Our decision to focus on peer-reviewed journal papers was made to keep the items in the corpus comparable and to code each paper across a variety of variables in line with the method of systematic literature reviews (León and Farris, 2011; Cheng et al., 2018). The restriction to studies published in English is due to resource constraints on translation from other languages.

*Criterion 2: the item should discuss public procurement and its role in innovation*

This is the relevance criterion. For the purposes of this review, ‘public procurement’ means purchases made by the government or contracts signed by the government to obtain goods, services, or works. This review aims to draw insights into the relationship between public procurement and innovation, including the role of public procurement as an innovation policy tool. Therefore, articles discussing innovations in the organisation and management of public procurement processes were excluded. Similarly, exclusive discussion of standards or the efficiency achieved from procuring new technology was not considered<sup>2</sup>. The search was conducted in February 2018, so the publication

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<sup>2</sup>The search strategy did not actively look for the use of policy terms like ‘PPI’ (public

Table 2.1: Search and selection of corpus

	Web of Science	Scopus	Business Source Premier	EconLit
<b>Hits</b>	1042	1516	1027	199
<b>Fulfilling Criterion 1</b>	706	647	351	106
<b>After removing duplicates</b>			1110	
<b>Removed for not fulfilling Criterion 1*</b>			125	
<b>Removed for not fulfilling Criterion 2</b>			985	
<b>Selected corpus</b>			110	
<b>Article could not be accessed</b>			11	
<b>Actual corpus examined</b>			99	

\*Some articles in languages other than English had been automatically included because they had an English summary and were removed at this stage.

time was fixed at an upper limit of 2017 for this study. The relevance criterion identified a corpus of 110 papers. Eleven of these articles could not be accessed<sup>3</sup>, leaving us with a corpus of ninety-nine journal papers (Table 2.1).

## Coding

Data from the corpus of publications was manually coded by reading all ninety-nine journal papers. The coding was guided by a coder manual (see appendix A.1). It was structured like a questionnaire to allow coders to examine the articles in the corpus for various information like themes, contexts, underlying assumptions, and methods.

## Inter-coder reliability tests

To test the robustness of the coder manual, an inter-coder reliability test was applied. A subset of ten papers was randomly selected from the corpus and coded by two independent persons using the coder manual. Inter-coder reliability can be calculated as percentage agreement and using Cohen’s kappa coefficient (Cohen, 1960). In percentage agreement, the percentage indicates the share of papers where two independent coders provided the same codes. In Cohen’s method, the statistic ( $K$ ) is calculated as  $K \equiv \frac{p_o - p_e}{1 - p_e}$ , where  $p_o$  is the observed agreement between two coders and  $p_e$  is the probability of chance agreement. Cohen’s kappa is considered a more robust measure to simple percentage agreement calculation as it takes the possibility of agreement occurring by chance into account.

A standard acceptable rate of percentage agreement is 80 per cent (Jones et al., 2015), and this was achieved for all but one of the variables (Table 2.2). The value of Cohen’s  $K$  ranges from  $-1$  to  $+1$ , where positive values reflect agreement and negative values reflect disagreement. Acceptable rates

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procurement of/for innovation’ or ‘PCP’ which is short for pre-commercial procurement. This is because the review seeks to include any research that describes public procurement as a possible demand-side innovation policy instrument rather than any specific conceptualization of public procurement as an innovation policy tool. At the same time, the use of terms like PPI or PCP did not lead to automatic exclusion of the articles.

<sup>3</sup>Six of the results did not lead to a paper on further search, and five could not be accessed with the institutional subscription available to the authors.

Table 2.2: Results of inter-coder reliability test

Variable	Coder 1 and Coder 2		Coder 1 and Coder 3	
	%age agreement	Cohen's K	%age agreement	Cohen's K
Type of article	80	0.286	90	0.429
Research method	90	0.615	100	1
Assumption/ rationale	60	0.545	100	1
Function of govern- ment (reason for procurement)	80	0.762	90	0.878
Level of procurement	80	0.74	100	1

for the Kappa coefficient are debated, especially amongst health researchers (see McHugh, 2012). Given that the calculation of the coefficient can be affected by sampling errors (Lacy and Riffe, 1996), it is sufficient to note here that none of the K-values are negative; that is, actual agreement was always more than chance agreement.

## 2.3 Findings and discussion

### The corpus and the evolution of the field

We begin by describing the corpus – its sources (in terms of publication outlets), the types of contribution made to the literature, and its history. This section provides a preliminary introduction to the literature, particularly highlighting its growth and diversity.

#### Temporal evolution of the corpus

The first paper in the corpus was published in 1976. Written by Keith Pavitt and William Walker, it reviews government policies that support industrial innovation, including “the encouragement of technically progressive procurement practices” (p. 76). The role of government demand in industrial innovation and technological change was a theme of several subsequent papers. Rothwell (1981) notes procurement as a possible government action to promote innovation in the economy and combat the global economic crisis that had set in after the 1973 oil price shock. Nelson and Langlois (1983) look at six industries and evaluate the success of government innovation policy, including procurement. Hutton and Hartley (1985) note the influence of procurement policy on R&D in the medical equipment industry in the UK and find that procurement by the National Health Service had positively influenced the level of research pursued by British medical equipment manufacturers. Mowery and Langlois (1996) study the US government’s role, including procurement by the Department of Defense, in the development of the software industry.

The corpus grew incrementally between 1976 and 2007 (Figure 2.1). A noticeable shift in growth can be detected from 2005, and the growth in the number of papers is almost exponential from 2008 (Figure 2.2). The structural break



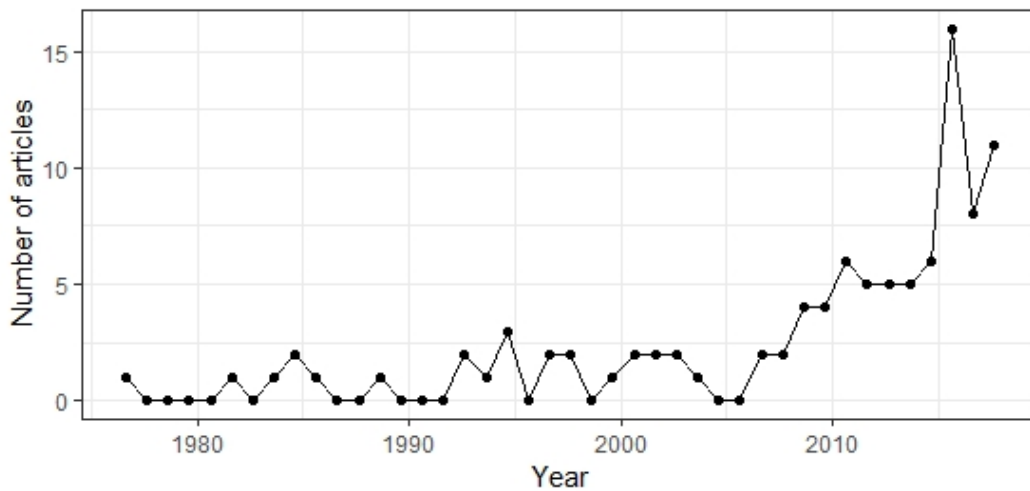


Figure 2.1: Research output over time (n = 99)

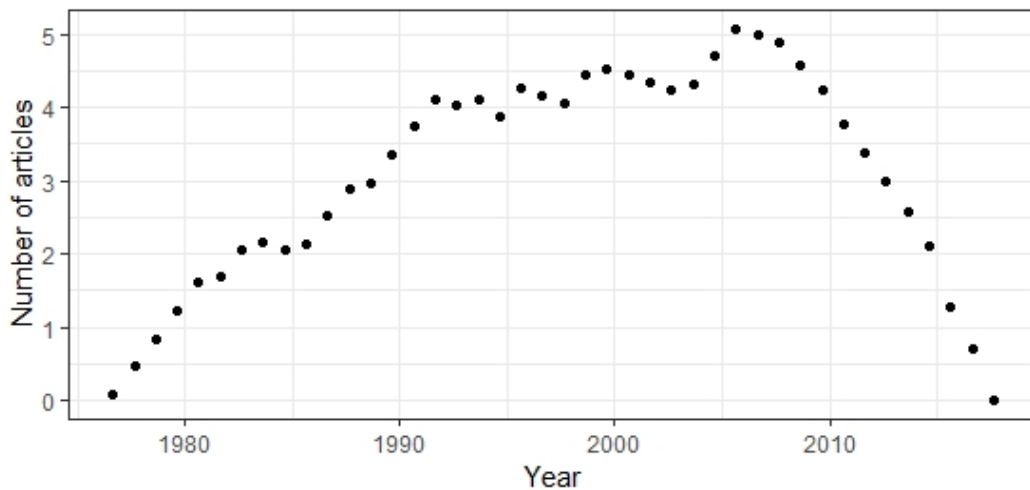


Figure 2.2: Cusum plot to detect structural break in corpus

was detected by using the cumulative sum (cusum) method to detect changes in the number of publications every year (Page, 1954). To address the issue of how best to demonstrate the changes that have occurred over the period in which the publications have appeared on this subject, and in particular the significant increase in interest in the topic indicated by a rise in the number of papers published at around 2005-10, we have calculated the cusum chart with publication counts transformed to lognormal. While the Shapiro-Wilk statistic for the resulting distribution of transformed publication is significant, indicating non-normality, the Q-Q plot and Z-scores for skewness and kurtosis are within acceptable limits with z-values of 1.44 for skewness and 0.72 for kurtosis<sup>4</sup>. From 2008, there is a marked increase in the number of journal

<sup>4</sup>The transformation has been undertaken because of the difficulties of using non-normal data for calculating cusum (Ryan and Faddy, 2001). From Figure 2.1 it is evident that the

articles published, peaking in 2015, when *Innovation – The European Journal of Social Science Research* published a special issue on the topic. Other indicators of growth and interest in the topic include the number of authors involved, the number of keywords, and publication outlets over time (Table 2.3). Since 2008, 121 researchers have published 70 papers across 44 journals on the topic of public procurement and innovation, which is striking when compared to early years. The potential reasons for this increase are explored in the following paragraphs, and a more detailed analysis of the diversity of keywords and journals is provided in the subsequent sections.

Table 2.3: Some indicators of academic interest over time

Time	Authors (first time contributors)	Keywords*	WoS Keywords <sup>†</sup>	Journals	Articles
1976 - 1987	7	0	0	5	6
1988 - 1997	20 (18)	14	10	10	11
1998 - 2007	23 (23)	40	17	11	12
2008 - 2017	121 (115)	189	146	44	70
Total	163	236	159	59	99

\*Author-provided keywords exist only for 66 of the 99 papers in the corpus.

<sup>†</sup>Web of Science generated KeywordsPlus could be obtained for 63 of the 99 papers in the corpus. 12 of these 63 papers contained WoS KeywordsPlus but not author-provided keywords.

With respect to the authors engaging in the topic, an interesting finding is that a large majority of authors in every decade are ‘first-time contributors’ in the sense that they have not appeared in the corpus before. In this respect, the 1998–2007 period seems remarkable as all the twenty-three contributing authors had not made any previous contribution to the study of public procurement and innovation but began contributing in this period. Perhaps this fresh interest in the topic can be explained by wider trends in policy and research on public procurement that began to emerge in the mid-1990s.

The significant growth of interest in the general topic area from 2008 is likely to have resulted in part from the engagement by innovation scholars in the development of EU and Member States policy on procurement during the first decade of the new millennium. The EU and Member State activity began to consider how procurement could play a role in developing the economy from the European Council of 2000 in Lisbon (European Council, 2000). At the same time that the EU was developing policy, the UK was launching its own variation on the US SBIR, although without immediate success (Connell, 2004; Bound and Puttick, 2010). Policy action at the EU level was relatively quick and the attempt to embed mechanisms to promote innovation through procurement law was achieved in the new procurement directives (2004/17/EE and 2004/18/EE). This was accompanied by high-level policy statements that supported the legal framework and its objectives (Kok, 2004; Aho et al., 2006). Additionally, the European Commission’s procedure for pre-commercial procurement (European Commission, 2007) came in 2007 which attempted to set out a procedure to promote innovation of new goods and services that by-

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distribution is not normal.

passed the directives (Rigby, 2016) and which, to some extent, reflected the operation of US SBIR (Apostol, 2017).

Those working in the academic environment, such as Edler, Edquist, and Georghiou were simultaneously involved in various international/supranational initiatives at the EU and OECD level and in the more abstract and theoretical discussion of the policy in academic circles. The 2007 *Research Policy* paper by Edler and Georghiou is the most cited text in this corpus of research articles focussing on public procurement and innovation, and both individuals participated in the EU-level dialogues (e.g., Professor Luke Georghiou was the rapporteur of the Independent Expert Group which produced the 2006 ‘Creating an Innovative Europe Report’). Forty-six of seventy research articles in the corpus published since 2008 cite this paper. A further key figure in the debate was Professor Charles Edquist whose coining of the acronym ‘PPI’ for ‘public procurement for innovation’ in 2009 was subsequently referred to by several authors (seventeen of sixty-two articles in the corpus refer to it since 2010). The use of this term and the related term ‘public procurement of innovation’ introduce an important difference of emphasis, which we discuss in our section on Thematic analysis (below).

The policy interest in procurement for the purposes of achieving innovation was the result of a wider revival of interest in the role of the state in the economy (Rolfstam, 2015) following the signing of the WTO Agreement on Government Procurement (GPA) which came into force in 1996. This new legal order required a wholesale re-examination of how governmental priorities for industrial development and national specialisation could be pursued. Differences began to appear, notably, between the European Union and the USA. In the European Union, ? has argued that the new policy framework placed more limitations on the use of public procurement to pursue goals of innovation, industrial policy, and growth than that created in the USA, where procurement as an innovation policy tool allowed the state to be entrepreneurial. Mazzucato (2013) stimulated further interest in this issue amongst academics and policymakers.

### **Where is the corpus found?**

The papers were published in fifty-nine different journals. However, Figure 2.3 indicates that the corpus is particularly concentrated in a few journals, with seven journals accounting for 40 per cent of the papers in the corpus.

Table 2.4 lists journals that have published at least three papers on public procurement and innovation. *Innovation – The European Journal of Social Science Research* leads the list, not least because it published a special issue on the topic in 2015 edited by Max Rolfstam from Aalborg University. The second-largest number of papers were published in *Research Policy*. *Research Policy* has seen an active discussion on the topic of public procurement and innovation over a long period going back to publications by Pavitt and Walker

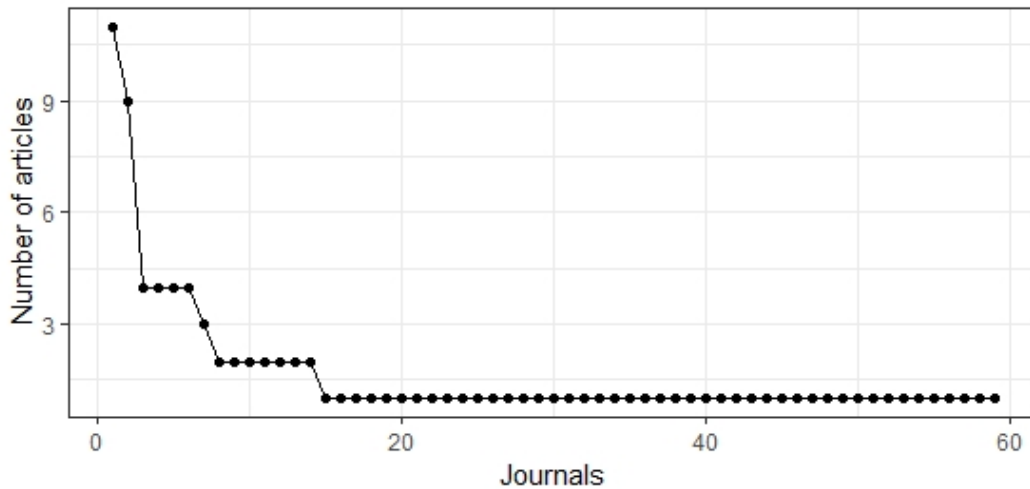


Figure 2.3: Distribution of corpus across 59 journals

Table 2.4: Journals with at least three articles in the corpus

Journal title	Count	Journal Impact Factor (2017)*
Innovation	11	1.018
Research Policy	9	4.661
Journal of Public Procurement	4	1.12 <sup>†</sup>
Science and Public Policy	4	1.368
Technological Forecasting & Social Change	4	3.131
Technology in Society	4	1.60 <sup>†</sup>
Technovation	3	4.802

\*Source: Web of Science InCites Journal Citation Reports 2017.

<sup>†</sup>Source: Scopus CiteScore 2017.

(1976), Hutton and Hartley (1985), and Mowery and Langlois (1996). *Research Policy* continues to publish highly cited articles related to the topic, notable among which is the Edler and Georghiou (2007) paper that stimulated renewed discussion on public procurement as a demand-side innovation policy.

Amongst the journals that have published at least three papers, there are top-ranked journals (by impact factor), including not only *Research Policy*, but *Technovation*, *Technological Forecasting & Social Change*, and *Science & Public Policy*<sup>5</sup>. In August 2018, *Science & Public Policy* published a ‘special section’ on the role of demand-oriented policies for innovation. While the corpus analysed in this research does not include contributions from 2018, the SPP papers which are included in the corpus offer important and interesting perspectives. Rolfstam (2009) explores the role of institutions in affecting the possibilities for public procurement of innovation, and Li and Georghiou (2016)

<sup>5</sup>The quality of journals (measured in terms of journal impact factor) in which the corpus is found might be of interest to some readers who may ask whether the increasing importance of the topic translates to publication in ‘higher impact’ journals. We used Scopus CiteScore 2018 and found no significant difference between the average impact factor of journals over time. We have not included a more detailed analysis of this point but would like to thank one of our anonymous reviewers for making this suggestion.

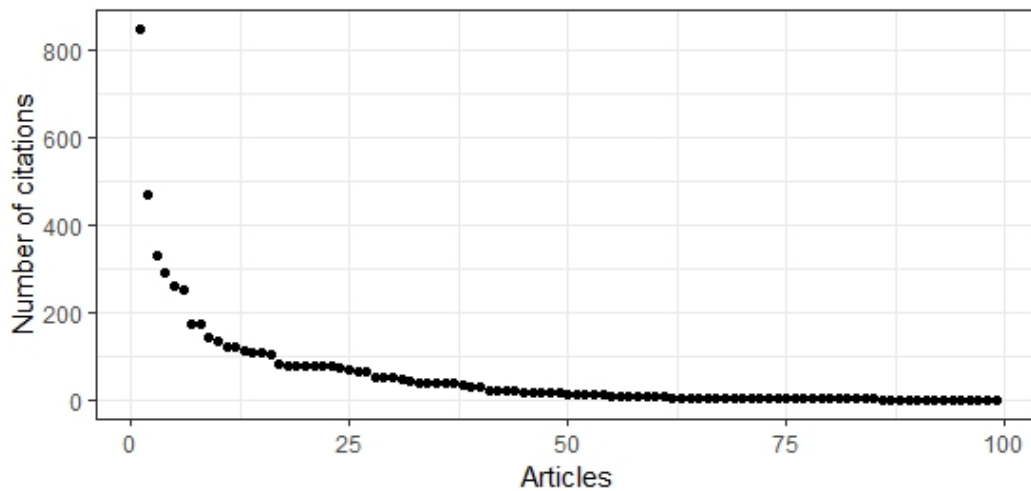


Figure 2.4: Distribution of articles by citation ( $n = 99$ ) as on 18 April 2018

argue about the differences between developed and developing countries with respect to public procurement and innovation.

It is worth noting that the journals with at least three articles are all in the field of innovation management and policy. The one exception is the *Journal of Public Procurement* which is a specialist journal that aims to further the understanding of public procurement. We find it interesting that the public procurement community has published so few papers on the consequences of public procurement for innovation. Most of the authors of papers in the *Journal of Public Procurement* are innovation management and policy scholars (e.g., Hommen and Rolfstam, 2009; Yeow and Edler, 2012).

To examine the highly cited articles within the corpus, citation counts were noted from Web of Science ( $n = 76$ ), Scopus ( $n = 84$ ), and Google Scholar ( $n = 99$ ). Since Google Scholar metrics are available for the entire corpus, the distribution of corpus by citation (Figure 2.4) is based on those figures.

The most cited paper on the topic of public procurement and innovation is the 2007 *Research Policy* paper by Edler and Georghiou titled ‘Public Procurement and Innovation – resurrecting the demand side’. The article emphasises the importance of the demand side as a potential source of innovation and argues for the place of public procurement as a demand-side measure in the taxonomy of innovation policy tools. The article goes on to discuss the rationales and justifications of public procurement policies that spur innovation as well as the challenges that such policies may face. It proposes public procurement of innovation as a possible important future public policy. However, in framing its recommendations, it does not include an extensive evidence base.

The second most cited paper is Edquist and Hommen (1999) in *Technology in Society*. Starting from the systems of innovation perspective, their paper

discusses innovation as an iterative, interactive learning process and points out that procurement is not just a matter of price signals and quantities but also a learning process through which the government conveys its requirements. Again, the approach is to layout a framework and scope for policy action. The authors declare that their aim is to identify “some elements of a general policy perspective” (Edquist and Hommen, 1999, p. 63). The third most highly cited paper (and the most highly cited by a non-European author in the corpus) is Lichtenberg (1988) in the *American Economic Review*. Lichtenberg emphasises the importance of government procurement by design and technical competitions as a means of encouraging private investment in research and notes the importance of “government revealing its demand for certain types of technological innovations” (Lichtenberg, 1988, p. 550). This relatively early investigation of the topic employs a model which tests firm-level data on R&D expenditure and share of competitive and non-competitive contracts for 169 firms between 1979 and 1984 in the USA at a time of a ‘major defence build-up’ (in the USA). The lessons of this research are supportive of the general case that government procurement through competitive procurement at scale provides incentives for higher R&D expenditure by firms and has potentially broader innovation effects.

### Types of journal papers

We also examined the types of journal papers found in the corpus. It is difficult to find a universal classification of journal articles, especially in the social sciences. Nissen (1996) developed a classification system to review engineering literature according to the paper’s contribution, and we adapted that typology<sup>6</sup>.

We coded the papers into one of four possible categories – (1) empirical, when the primary contribution of the article is information on a case or policy evaluation (using either or both qualitative and quantitative methods); (2) methodological, when the article provides different approaches to analyse data and addresses the research topic in methodologically novel ways; (3) investigative, when the article probes theory and practice to develop guidelines and frameworks for further research, and (4) theory-building, when the primary purpose of the article is to propose testable models and hypotheses<sup>7</sup>.

Articles making an empirical contribution to the literature were most common (fifty-five of ninety-nine). These mainly highlighted policy practice and provided case studies of public procurement as a demand-side innovation policy. Some of these articles chose to focus on a particular industry in a particular country – for example, satellite telecommunications in Italy (Landoni, 2017),

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<sup>6</sup>Nissen (1996) classifies publications into five categories – trade press, redesign cases, expert reengineering methodologies, academic investigations, and theory-building works. We did not classify any articles as trade press and adapted the categories to better suit the types of contributions we noticed in the corpus.

<sup>7</sup>In case an article proposes a testable model/hypothesis and uses empirical data to test it, it would continue to be classified as ‘theory-building’ based on its primary contribution.

biorefineries in Sweden (Hellsmark and Söderholm, 2016), while others chose a number of industries or economic sectors to evaluate national (and sometimes regional or local) policies on public procurement and innovation – like in the UK (Gee and Uyarra, 2013), China (Li and Georghiou, 2016), or the USA (Alic, 2015). While a majority of these empirical contributions conclude their work with positive remarks and are hopeful about the use of public procurement as an innovation policy instrument, some are cautious – Li and Georghiou (2016) note that “the appropriateness and effectiveness of such instruments are closely dependent upon the state of both the innovation and the procurement systems in which they are set” (p. 349), and a few diverge from the view that public procurement can be an effective innovation policy tool (Walsh, 1993; Davis and Brady, 2015; Meehan et al., 2017).

Second in order of frequency are investigative articles (twenty-four of ninety-nine) that review trends in literature and policy practice to suggest frameworks for further research on the topic. These include seminal texts like Pavitt and Walker (1976) and Edler and Georghiou (2007), as well as Rolfstam (2009) which talks about institutions, Kattel and Lember (2010) which explores the feasibility of using procurement as a demand-side innovation policy in a developing country context, and Edquist and Zabala-Iturriagoitia (2012) which examines public procurement for innovation as a ‘mission-oriented’ innovation policy. Investigative articles often explore different ways that would help to make public procurement more effective as an innovation policy tool and seem to agree that public procurement is most effective when the government (or public) is itself a user of the product, service, or system. The various contributions on improving procurement policy with respect to innovation include coordinating demand and supply-side policies for innovation to reduce the risk of contradiction or non-coherence (Rothwell, 1981), the use of innovation-friendly procurement at all levels of government (Uyarra and Flanagan, 2010), and the use of project management strategies (Yeow and Edler, 2012).

There are thirteen papers in the corpus that make a primarily methodological contribution to the literature. For example, Aschhoff and Sofka (2009) use Tobit modelling to compare public procurement with other innovation policy instruments to understand the unique contributions of public procurement, and Markovic-Hribernik and Detelj (2016) measure the impact of public procurement towards innovation by running regressions on an EU-wide panel data. Nine of the thirteen papers find positive evidence about the use of public procurement as an innovation policy tool. However, not all methodological contributions relate to the use of quantitative methods. For example, Li (2017) proposes using two dimensions of policy coherence (horizontal and vertical) to assess the process and practice of public procurement of innovation.

There are seven articles whose primary contribution is theory-building by proposing testable, falsifiable models that link public procurement and innovation. For example, Lichtenberg (1988) proposes that firm R&D levels respond positively and significantly to government procurement competitions, Dalpé

et al. (1992) create a model to test the importance of government’s role as the ‘first user of innovation’ in promoting technological development in various industries, and Goel (2001) develops a principal-agent model to test how R&D efforts by the agent (supplier) are affected by the varying degrees of control imposed by the principal (government contractor). Although few in number, by modelling the conditions under which public procurement can be expected to succeed as an innovation policy, these papers provide considerable support to the research on public procurement and innovation.

## **Thematic analysis**

We now turn to discuss our findings related to themes in the corpus. These help us to understand the research directions and areas of interest for the research community. Keywords provide a simple indication of themes, vocabulary, and its diversity. Semantic analysis of larger bodies of texts (like abstracts) allows the identification of thematic groups and their proximity and level of interactions.

### **Keywords**

Keywords help in searching for articles and help connect researchers who share similar vocabularies. Sixty-six of the ninety-nine journal articles listed keywords, and therefore comments cannot be made about the entire corpus<sup>8</sup>. However, even these sixty-six journal articles yield 236 distinct keywords, of which only ten appear at least three times which indicates a diverse vocabulary. ‘Public procurement’ is the keyword in thirty-three papers, leading the list as the most frequently used keyword, followed by ‘innovation’ with twenty-seven and ‘innovation policy’ with thirteen instances of use. Another popular keyword is ‘demand’ (ten instances). There are variations in the use of ‘public procurement’ and ‘innovation’ which combine the two terms – three instances of ‘public procurement of innovation’, two of ‘public procurement for innovation’, and one of ‘public end-user driven technological innovation’.

The most frequent keywords reflect the broad boundaries of the corpus, but it is the less frequent keywords (but occurring more than once) which provide insights into the interests of the corpus. There are five instances where ‘industrial development’ (or a similar term) is used to convey an interest in the use of public procurement and innovation for promoting industrial growth (Shyu et al., 2001; Srinivas, 2006; Malerba et al., 2008; Myoken, 2010; Matelly and Lima, 2016). The term ‘interactive learning’ is used by three papers to draw attention to a systemic, iterative model of innovation, where demand and supply elements need to interact to create something new (e.g., Edquist and Hommen, 1999; Edquist and Zabala-Iturriagoitia, 2012; Phillips et al., 2007).

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<sup>8</sup>Since the number of papers with author-provided keywords exceeds the number of papers with WoS KeywordsPlus and since it may not be wise to merge author-provided and automated keywords, only author-provided keywords have been used for analysis.



There are different keywords to suggest interest in topics like health – ‘health care’ (Walker and Preuss, 2008; Meehan et al., 2017) and ‘medical technology’ (Torbica and Cappellaro, 2010; Sorenson and Kanavos, 2011), and environmental protection – ‘renewable fuels’ (Alic, 2015; Aldenius and Khan, 2017), ‘environmental innovation’ (Ghisetti, 2017), and ‘sustainability’ (Cerin, 2006; Walker and Preuss, 2008; Gee and Uyarra, 2013; Cohen and Amorós, 2014). One recent paper in the corpus uses the term ‘green public procurement’ (Aldenius and Khan, 2017). A systematic literature review on green public procurement (GPP) was recently published (Cheng et al., 2018), and GPP appears to be a special branch of public procurement and innovation which focuses on public procurement for environmental protection.

### **Analysis of abstracts**

Shared keywords and terms imply the existence of a research community. This can be probed further by conducting semantic analysis of texts and producing a co-occurrence network based on the terms extracted. In this study, we used the abstracts from the ninety-nine papers to identify co-occurrences of terms.

To generate our co-occurrence network, we conducted a textual analysis. We uploaded the corpus of abstracts to Cortext, an open-source lexical analysis software platform. With the condition of at least two occurrences in abstracts at the document level, terms extraction produced a list of 221 terms. The list of terms was scanned and irrelevant terms were manually removed. A list of 135 terms remained.

As with our analysis of keywords, ‘public procurement’ and ‘innovation policy’ occur most frequently in the abstracts, but what is more interesting is the variety of ways in which the link between public procurement and innovation is expressed, the most popular being ‘public procurement for innovation’, and ‘public procurement of innovation’ (twelve documents each). Edler and Georghiou (2007) provide the first instance of the use of ‘public procurement for innovation’, and Rolfstam (2009) is the first instance of the use of ‘public procurement of innovation’. Rolfstam (2015) later suggests that an important difference between the two terms, which is generally observed in their use, is that public procurement *for* innovation refers to the procurement of ‘goods and services that do not yet exist’ (an expression used by Edquist and Hommen (1999)) and tends to denote ‘technology procurement’, while public procurement *of* innovation is broader in its meaning, denoting public procurement that leads to innovations of any kind (like innovation in the procurement process or through the combination of existing technologies).

It is also interesting to note which terms occur together. To form a network of the terms extracted from the abstracts, the terms were mapped using the Louvain method (Blondel et al., 2008). In the network, nodes represent the terms and the edges represent documents that connect these terms. Clusters of terms are formed on the basis of optimal modularity, i.e. the density of edges

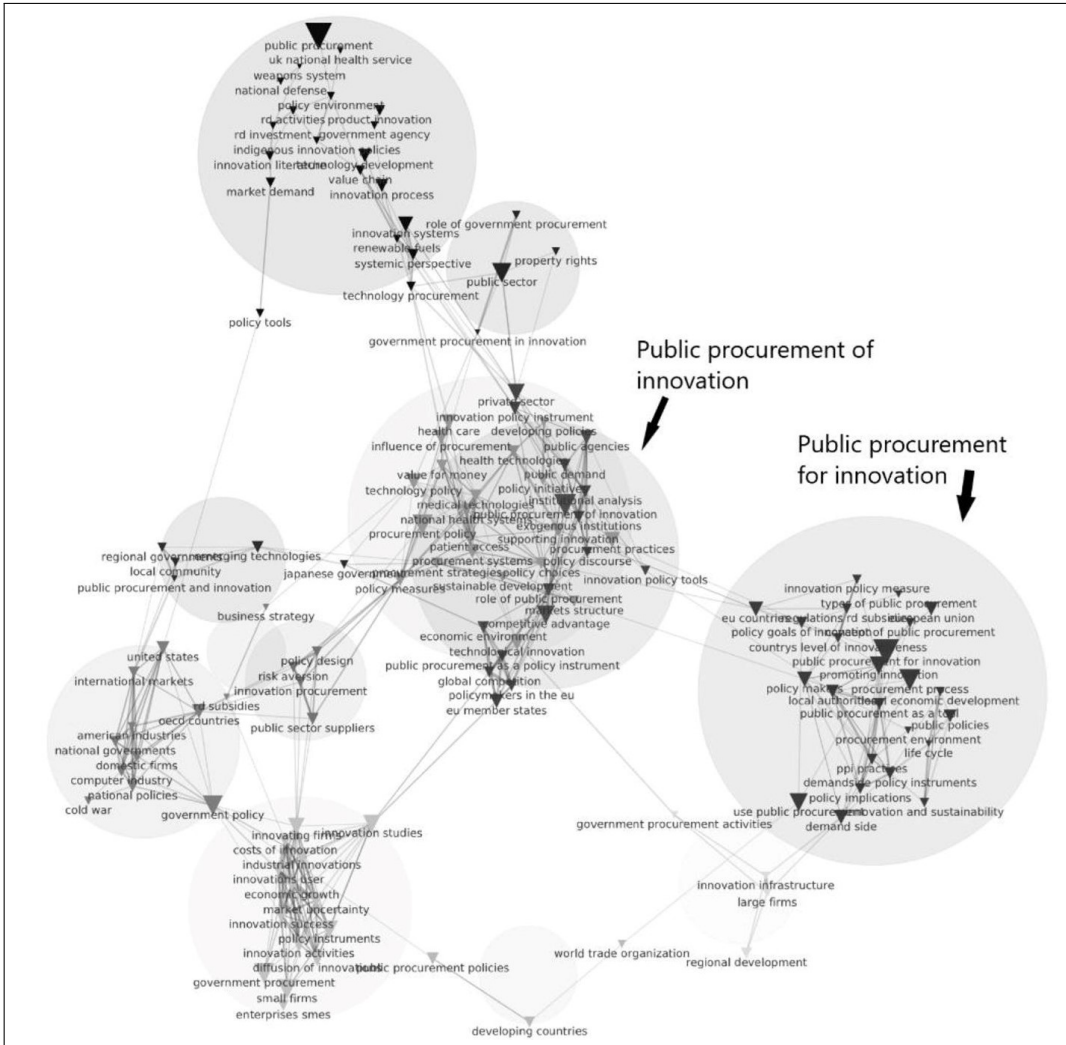


Figure 2.5: Homogenous network of terms extracted from abstracts

inside the clusters (compared to the outside) is optimised to detect clusters or communities in the network.

Several close-knit communities can be found by analysing the network (Figure 2.5). ‘Public procurement of innovation’ and ‘public procurement for innovation’ occur in different (although not disconnected) communities. The term ‘public procurement of innovation’ co-occurs with terms like ‘policy initiatives’ and ‘institutional analysis’, and ‘public procurement for innovation’ co-occurs more prominently with terms like ‘European Union’. Both ‘public procurement of innovation’ and ‘public procurement for innovation’ belong to clusters with terms like ‘EU member states’ and ‘policymakers in the EU’, suggesting an association between European Commission-led policy initiatives and papers on this subject.

Some other important clusters revealed by the analysis are the ones on the bottom-left of the figure 2.5. Linked by ‘government policy’, both the clusters

have terms that can be associated with industries and industrial innovation ('american industries', 'domestic firms', 'computer industry', 'small firms', 'enterprises and SMEs'), which reflects the original interest of the topic in studying public procurement as a government policy tool for promoting innovation in industries. Another cluster in the figure contains terms like 'value chains', 'innovation systems', 'market demand', 'policy tools', and 'government agency'. This suggests a potential interest in, or application of, the systemic perspective in studying innovation theorised by Lundvall (1985) and Nelson (1993). Another cluster shows co-occurrence and proximity of terms like 'regional government' and 'local community', exemplifying meso-level studies in the corpus (Rothwell, 1984; Lember et al., 2011; Dale-Clough, 2015).

## **Public procurement and innovation: justifications and contexts**

By examining the articles for the justifications provided and their contexts, it is possible to characterise research on public procurement and innovation along several dimensions. Identifying the justifications in a research corpus helps to appreciate the philosophies that inform the development of the field. Knowledge about the research contexts helps to identify dominant interests as well as overlooked areas which can inform further research efforts.

### **Justifications**

What are the justifications used in the literature to link public procurement and innovation? Edler and Georghiou (2007) identified three justifications for the use of public procurement as an innovation policy tool and called them 'rationales': the importance of lead user and demand, market and system failures, and the applicability of public procurement towards improving public policy and services. Chicot and Matt (2018) also describe policy rationales of public procurement and innovation research using the concept of failures which justify the policy. They identify three types of failures: demand-side failures relate to the provision of public services and adoption and diffusion of technology; supply-side failures relate to the incentives and capacity of producers to engage with research and development; and user-supplier interaction failures relate to uncertainties related to information asymmetry and lack of interactive learning spaces.

In our corpus, we encountered various justifications linking public procurement and innovation that could be classified into three categories, informed by the existing frameworks. The first is the 'buyer and user' rationale, where the government engages as a user (sometimes the 'first user') of a product or service. The 'buyer and user' rationale focuses on the importance of demand (expressed through procurement) for the development of technology, but also includes the importance of interaction with and perspectives from the user. The second type of rationale is the 'market failure' rationale. These justifications usually emphasize on the ability of public procurement to generate

incentives for producers and suppliers to engage in innovation and technology development, which the market on its own is not able to generate. Finally, the third type of rationale is the ‘public services’ rationale, where the application of public procurement as an innovation policy is justified for improving the provision of public services.

The papers were coded according to ‘buyer and user’, ‘market failure’, and ‘public services’ rationale. Where more than one rationale was discussed, we coded multiple rationales. All ninety-nine papers were coded and the degree of overlap and relative sizes of the three rationales in the corpus is indicated in a Venn diagram in Figure 2.6. A total of forty-two articles refer to the ‘buyer and user’ rationale, and the corresponding numbers for ‘market failure’ and ‘public services’ rationales are fifty and forty, respectively.

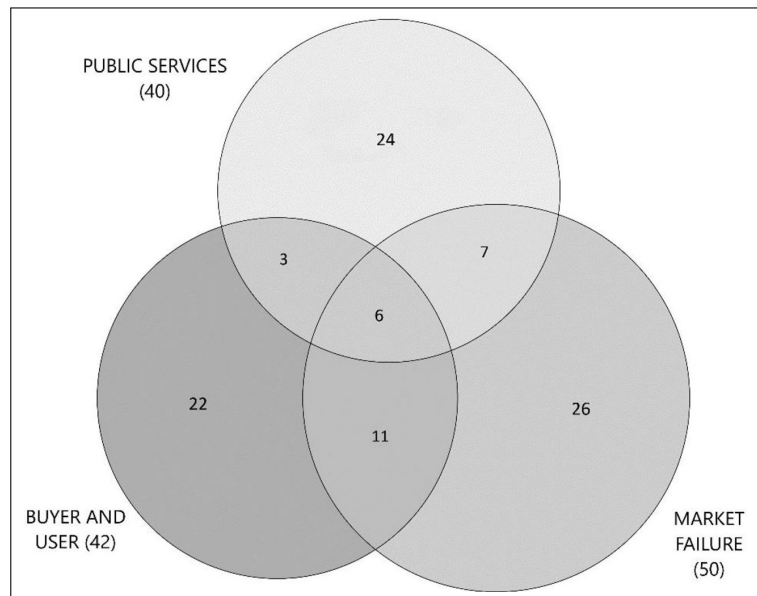


Figure 2.6: Venn diagram on the use of justifications in the corpus (n = 99)

Seventy-two of the ninety-nine articles used just one of the rationales. The ‘buyer and user’ rationale is discussed exclusively in twenty-two papers. ‘Public services’ is examined exclusively in twenty-four papers. Only six papers consider all three rationales. The mutual exclusivity, i.e., the reference to only one of the rationales in seventy-two of the ninety-nine papers, would suggest that the literature has developed by using different justifications and theoretical bases.

## Contexts

A large number of papers had a clearly defined research focus in terms of the purpose of procurement, by which level of government, and in which country. A systematic review helps to reveal the dominant and overlooked contexts in research.

**Reason for procurement** The UN classifies government functions into ten categories. This classification was adapted to identify the reasons for public procurement covered in the corpus in order to get a sense of the purpose of public procurement. Seventy articles referred to at least one of the ten functions.

Procurement of technology for environmental protection and health (medical equipment, hospital services) dominate the list (Table 2.5). The popularity of environmental protection as a reason for public procurement is related in part to the development of green public procurement (GPP) as a topic related to public procurement and innovation research. In this literature, the intention to mobilise procurement towards the purchase of environmentally-friendly goods and services is sometimes discussed alongside promoting innovation and technological development. Manufacturing industries and ICT industries are also often discussed as case studies when public procurement is motivated towards improving the manufacturing sector and/or developing a more technology-driven manufacturing industry. Technology procurement for defence is discussed in fifteen papers, many of which discuss the role of military demand in technology development (Nelson and Langlois, 1983; Mowery and Langlois, 1996; Alic, 2008).

Table 2.5: Government functions fulfilled by technology procurement

<b>Function of government</b>	<b>Number of articles</b>
Environmental protection	18
Health	18
Construction*	16
Communication†	15
Defence	15
Public safety and social protection	11
Transport	9
Housing and community development	6
Agriculture, forestry, fishing, fuel, energy, and mining	5
Education	5

\*These refer to public works — construction of buildings, roads, etc.

†This refers to government's role in establishing infrastructure and communication networks.

**Level of government** Public procurement can be conducted at different levels of government: national, regional, or local. Almost all papers in the corpus defined the level of government at one of these levels, except for two which considered procurement at a multi-national level and therefore could not be classified in any of the three categories. Seventy-three papers look at national government procurement policy and practice, forty-three at the local level (municipality, city council), and thirty-two at the regional level. A partial explanation for the dominance of the focus on national-level government could be that many of the reasons for pursuing procurement occur for functions of government that are performed by or require coordination at the national level, like environmental protection, public health, and defence (Table 2.5).

Although reference to regional government procurement and policy can be found in early years (e.g., Rothwell 1984), Table 2.6 shows that public procurement and innovation research has become more diverse with respect to the level of government in the last ten years with several works that seek to draw attention to local-level policy making (e.g., Pickernell et al. 2011; Dale-Clough 2015; Zelenbabic 2015; Uyarra et al. 2017). The share of corpus exclusively considering procurement by national governments has reduced over time.

Table 2.6: Level of government studied by articles in the corpus

Years	1976 – 1987	1998 – 1997	1998 – 2007	2008 – 2017	Total
National (exclusively)	4	6	7	28	45
Share of corpus (in %age)	66.6	54.5	58.3	40	45.5
Regional (exclusively)	0	1	0	5	6
Share of corpus (in %age)	0	9.1	0	7.1	6.1
Local (exclusively)	0	0	0	13	13
Share of corpus (in %age)	0	0	0	18.6	13.1
National and regional	0	1	0	2	3
Share of corpus (in %age)	0	9.1	0	2.9	3
National and local	0	1	0	6	7
Share of corpus (in %age)	0	9.1	0	8.6	7
Regional and local	2	0	0	3	5
Share of corpus (in %age)	33.3	0	0	4.3	5.1
All three levels	0	2	4	12	18
Share of corpus (in %age)	0	18.2	33.3	17.1	18.2

**Country** An important variable in terms of research context, especially in policy research, is the country<sup>9</sup>. We coded the papers for the countries that were the focus of the articles: eighty-five of the ninety-nine articles situated their study in one or more countries, and twenty-eight countries can be identified. We classified the European Union as a sovereign entity when EU policy is discussed. The frequency distribution is provided in Table 2.7. The UK is the most commonly studied country in the corpus, closely followed by the USA. Several European countries follow. China is the most frequently studied non-western country and has been receiving a lot of attention for its use of public procurement as an innovation policy in recent years.

Table 2.7: Frequency of countries studied in the corpus

Country	Number of articles
United Kingdom	22
United States	20
European Union	11
Sweden	8
Finland; France; Germany	7
China	6
Italy; Japan; Netherlands; Spain	5
Norway; Switzerland	4
Denmark	3
Canada; Estonia; Greece; Latvia; Poland	2
Australia; Brazil; India; Ireland; South Korea; Singapore; Taiwan; Turkey	1

<sup>9</sup>The restriction to publications in the English language may be affecting results on this point of analysis.

Remarkable in their low numbers and absence in Table 2.7 are non-OECD, non-EU countries. One explanation for this neglect can be found in Detelj et al. (2016). In their review of public procurement and innovation research in different countries, they note that the proliferation of studies in the USA, the UK, and western Europe may indicate better awareness of policy possibilities, whereas public procurement and innovation studies in countries like Croatia and Serbia focus on improving the efficiency of public procurement and reducing corruption. The literature so far comes from a very western, liberal-democracy specific point-of-view and there may be potential in investigating the opportunities and challenges of using public procurement as a demand-side innovation policy tool in non-OECD, non-EU countries. China would seem an obvious focus for research.

## 2.4 Conclusion

Academic interest in public procurement and innovation has grown significantly. The role of government as a buyer and user of goods and services is emerging as an important focus in discussions about the role of government in promoting innovation. In any body of research, a systematic literature review is a useful first step in consolidating knowledge on the topic. By searching and annotating journal articles that refer to public procurement and innovation, this review helps to characterise the literature, comment on its evolution, and identify key themes, underlying assumptions and coverage of contexts.

A variety of terms are used in the literature – ‘public procurement of innovation’ and ‘public procurement for innovation’ being the most popular. Studies on public procurement for environmental protection and sustainable development have recently started referring to themselves as ‘green public procurement’. In order to keep all these variants of public procurement and innovation studies together under one umbrella, it is important to strengthen the underlying theories that serve public procurement and innovation so that the field is easier to recognise across diverse themes. The finding that papers recognise very different justifications linking public procurement and innovation further emphasises the need to have more consensus about the foundations of the topic.

In addition to a need for rigorous theoretical work, there is also a justification for paying attention to overlooked empirical contexts and testing the applicability of public procurement and innovation concepts in different scenarios. While there is diversity in contexts in which the empirical research is situated – the reasons for procurement, the level of government conducting the procurement, and the country being considered – the contexts are rather unequally represented in the corpus. The empirical work mostly relates to the UK, USA, and western European countries. Greater diversity of empirical contexts may lead to a more universal understanding of the topic.

Therefore, given the present state of knowledge on this topic, we conclude that

policymakers should be cautious in applying public procurement as an innovation policy tool because the policy has only been applied in a few countries and a few contexts. The use of public procurement as a demand-side innovation policy tool has been conceptualised and tested with a few case studies and examples for the most part. Only five papers curate and measure evidence and impact of the policy. Although there is a consensus over the importance of demand in promoting innovation and technological development, the academic literature rarely addresses questions on impact. The lack of studies on impact has limited the scope of this systematic review to be a meta-analysis on public procurement as an innovation policy.

We propose two directions for future research. The first is more effort focused on constructing theoretical frameworks. There is currently very little theory-building work in the corpus, and given the need to develop a better understanding of demand generally and the role of demand in innovation policy in particular, we regard it as important that more work is carried out in this area. A second direction is empirical. Future research should seek a greater variety of contexts for empirical testing of public procurement and innovation policy concepts. In particular, more research on public procurement and innovation should be conducted in non-OECD and non-EU countries.



## Notes on defence

The review shows that existing research on public procurement and innovation is to be found in both defence and civilian contexts. Table 2.5 notes that there are 15 papers within the corpus which mention ‘defence’ as the function of government being fulfilled by procurement, i.e., defence as a reason for procurement. In addition, there are two more articles in the corpus (Rothwell, 1981, 1984) which make a brief reference to defence procurement.

Of these, six articles mentioned some characteristics of defence procurement and argued that these are unique to the defence sector. These characteristics were: an oligopolistic market structure (Caldwell and Howard, 2014), the prevalence of cost-plus contracts (Rothwell, 1984), greater legitimacy from the public (Nelson and Langlois, 1983), an overwhelming importance of technical performance (Dalpé et al., 1992), and the specificity of requirements preventing spillovers into other sectors (Rothwell, 1994; Markowski et al., 1997). However, it is interesting to note that many researchers did not engage with or chose to ignore any perceived peculiarities or differences of defence procurement when studying public procurement and innovation.

Additionally, characteristics like oligopolistic market structure and greater public legitimacy can be challenged. Heinrich (2002) as well as Caldwell and Howard (2014) point out that unique relationships between suppliers and customers are to be found in non-defence industries as well, since imperfect market structures exist in procurement more generally. Nelson and Langlois (1983) write that “public belief in the legitimacy of the government’s primary mission – defence – smooths the political waters for any related program of government R&D support” (p. 816), but this could be context-specific. Their paper considers innovation and procurement in the USA, a country that is exceptional in terms of its military capacity and orientation than other nations.

## Further contributions to the thesis

The review of public procurement and innovation literature revealed some of the concerns associated with the implementation of public procurement as an innovation policy tool. An ever-present challenge seems to be the potential for innovation-friendly procurement policy to morph into industrial protectionism and reduced competition (Pavitt and Walker, 1976; Edler and Georghiou, 2007; Li and Georghiou, 2016). This focus on market competition prompted me to further explore the markets in which public procurement for large and complex products involving innovation takes place. Rarely, if at all, does procurement of complex products occur in a perfectly competitive market.

In an imperfect market, the market cannot correct for information asymmetry, generate competition, and mediate on the price (Keisler and Buehring, 2005). In the case of standardised products, public procurement law usually favours the selection of the lowest bidder. However, lowest price bidding is not helpful

in the case of non-standardised items (i.e., items requiring a high degree of customisation). Chang (2013) demonstrates how lowest price bidding in a situation of incomplete contracting, as was the case for the Channel Tunnel Rail Link, cannot guarantee efficiency since the costs of ex post renegotiation can exceed ex ante surpluses. Contracts involving research and development are particularly susceptible to under-investment of efforts by the supplier as a firm's research behaviour is difficult to observe, and often the optimal contract would be an incomplete contract (Goel, 2001; Tadelis and Bajari, 2006).

Transactional complexity affects contractual processes in public procurement (Araujo and Spring, 2011) and raises questions about frictions and transaction costs (Williamson, 1979). Novel organisational arrangements may be introduced to control frictions, but there are challenges in integrating and building sustainable relationships amongst the different participants (Naghizadeh et al., 2017; Tee et al., 2019). The public procurement environment can thus become institutionally complex, i.e. characterised by multiple and conflicting institutional logics emanating from the different organisations and professional groups (Greenwood et al., 2011). Project stakeholders coming from different organisations and professions could be adherents of different institutional logics and struggle to cooperate (Biesenthal et al., 2018; Tee et al., 2019). This makes institutional theory an important lens for studying public procurement, and the next research paper is based on institutional theory. Thus, the next chapter of the thesis emanates from the research work of this chapter.

Further, the observation regarding the effects of the political environment on procurement and possible American exceptionalism motivated me to explore public opinion towards defence procurement. This research led to the third research paper within this PhD and is presented in Chapter 4.

## Chapter 3

# Institutional explanations for frictions in public procurement

This chapter presents the second of the three papers. The paper applies institutional theory to the public procurement landscape. There are two reasons for pursuing research in this manner. Firstly, the previous chapter suggested that the transactional complexity of public procurement can make the procurement landscape institutionally complex by bringing together distinct institutional logics from the various organisations involved in the procurement activity. Transactional complexity may be particularly acute in the procurement of large and technologically complex items which is of interest for this thesis.

Secondly, institutional theory is useful for comparative studies as it facilitates the identification of similarities and differences between distinct fields. This links to the overarching aim of the thesis, which is to compare defence and non-defence public procurement. Adopting the institutional lens, this research paper compares the level of institutional heterogeneity in the military and non-military procurement landscape.

Empirically, the gaze shifts towards the practice of public procurement, responding to the second direction of the research framework presented in Chapter 1. There is also a shift in focus from innovation policy (Chapter 2) to project management in this and the next chapter. This is primarily because projects are considered the most appropriate analytical unit for studying large and technologically complex systems whose procurement is more likely to require innovation. Hobday (1998) proposes projects as an analytical category because the development of technologically complex systems requires the combination of multiple technologies and skills from different organisations. Therefore, the delivery of such items is managed through the vehicle of projects, rather than through a specific organisation or industry. The study of projects led to project and operations management literature for theoretical and conceptual groundwork.

This paper took shape in 2019 and an early draft was presented at the Comparative Agendas Project conference in July 2020 with the title ‘Analysing talk and comparing conversations on military and civilian public projects’. It was also presented at the American Political Science Association annual meeting in September 2020 as a poster and at an Early Career Research webinar organised by EU-SPRI in June 2021. As with the previous chapter, I begin by presenting the research as a journal-style research article which I intend to submit to an appropriate journal in operations and technology management, following thesis submission. At the end of the paper, I provide some notes highlighting the contributions of the research specific to the thesis.

## Abstract

This paper provides an explanation for challenges in public procurement by using institutional theory and the concept of institutional logics. Text analysis was performed on transcripts of parliamentary committee hearings, a setting where different groups involved in public procurement present their perspectives on major projects as part of the Parliamentary scrutiny of government policy. Topic modelling of texts related to four procurement projects reveals significant differences in vocabulary choices of the different participants in the public procurement process (civil servants, ministers, members of parliament, industry executives). Differences in vocabularies in this dataset are all the more interesting to discover because participants are engaging in the same conversation.

The study mobilises institutional theory to understand public procurement challenges. Differences in institutional logics, expressed as differences in language and vocabulary used by different stakeholders, provide evidence of the pre-conditions for frictions in the procurement process. The study is exploratory, and further research on institutional logics amongst public procurement participants, using more indicators of institutional logics, will make it possible to examine the claims made in this paper in greater detail. The methodology of text analysis and topic modelling is easily adaptable and transferable to different empirical contexts and may be of value to other researchers. Public project managers accustomed to the inherently risky nature of public projects may find the insights on language and vocabulary choices interesting and consider intermediation strategies and training among project partners.

**Keywords** Procurement, Public sector, Project management, Institutional theory, Topic modelling, Text analysis

## 3.1 Introduction

The purchasing activity of the government, or public procurement, is an important topic of research as it operates in a political as well as in an economic

environment. Public procurement projects often assume the form of ‘megaprojects’ – large-scale and complex ventures that are resource-intensive, take many years to develop, and can impact millions of people (Flyvbjerg, 2014). Complex contractual arrangements are often required, and management and leadership skills are put to the test in megaprojects to fulfil objectives beyond cost efficiency, especially innovative outcomes (Caldwell and Howard, 2014) or sustainability (Meehan and Bryde, 2015). The different objectives may not be shared equally amongst the large number of public and private project stakeholders and can create challenges in the procurement process.

Existing research on public procurement explains the challenges in terms of the principal-agent relationship (Bajari and Tadelis, 2001; Schiele and McCue, 2006). Opportunistic agents responding to incentives and carefully crafted contracts underlines much of the work on public procurement. More recently, researchers have started exploring institutional theory for understanding the frictions and challenges in public procurement (Busck, 2007; Meehan et al., 2016; Stenius and Storbjork, 2020).

Institutional theory assumes that deeply established norms and beliefs, or ‘institutions’ guide individual behaviour and actions (Scott, 2013). Organisations, professions, and social systems have unique and distinct institutional logics (theories, frames, vocabularies, practices, and symbols) which regularise and constrain behaviour (Friedland and Alford, 1991). The interaction of different logics leads to a variety of outcomes, ranging from a replacement of the prevailing logic, the transformation of logics, or even reinforcement of existing logics (DiMaggio and Powell, 1983; Besharov and Smith, 2014).

Mobilising institutional theory allows us to include the broader environment within which a project is situated (Morris and Geraldi, 2011) and is particularly relevant for understanding the challenges that could result from the interaction of different stakeholders (Aaltonen and Kujala, 2016; Biesenthal et al., 2018). Public procurement is a transactional process, and frictions – a common metaphor for transaction costs (Williamson, 1985) – can occur when different stakeholders disagree or fail to cooperate. With their high stakes, diverse stakeholders, and multiple objectives, public procurement projects are prone to experiencing frictions and resistance. The concept of institutional logics gives procurement researchers new explanations for the challenges that emerge from having multiple stakeholders in a public project. The primary aim of this paper is to demonstrate the use of institutional theory to understand the challenges of public procurement.

Methodologically, we exploit the role of language and vocabularies in conveying inherent institutional logics (like Suddaby and Greenwood, 2005; Meyer and Hammerschmid, 2006; Jones and Livne-Tarandach, 2008). We use an automated text analysis called ‘topic modelling’, and in doing so we respond to the call by Biesenthal et al. (2018) regarding “how to carry out research in megaprojects applying institutional theory” (p. 50). A novel research method

is not only useful for exploiting different sources of data and triangulating research findings but can also offer new perspectives. Topic modelling, with its focus on language and vocabularies, can have implications for our understanding of the sources of institutional differences. We use transcripts of parliamentary committee hearings on public procurement projects to identify words and vocabularies associated with different groups.

As a quantitative technique, topic modelling also makes a comparative approach possible, i.e., comparison of institutional differences or the levels of institutional heterogeneity between two or more project landscapes. Therefore, this paper also involves an exploratory comparative study between two fields – defence and public transport. The empirical context of this work consists of four large public procurement projects in the UK of which two are led by the Ministry of Defence (MoD) while the other two are led by the Department for Transport (DfT). Defence and public transport are important functions of government, and in the UK both the MoD and DfT are large in terms of budgets and staff numbers. Defence is an important sector in procurement studies, and the DfT has become prominent in recent years for its involvement in the procurement of trains. Therefore, we ask whether stakeholders in the field of defence are more/less likely to experience differences in language and vocabulary choices than stakeholders in the field of public transport?

From a practical perspective, our research provides insights on an easily overlooked dimension in public procurement, i.e., language and vocabulary choices. It can be difficult to cooperate if project partners use different vocabularies. There may thus be a case for greater investment in intermediaries like professional services that can act as bridges or connecting nodes. There already exists research on coordination mechanisms between hybrid organisations, firms in temporary, mission-oriented organisations (Fernandes et al., 2018) and in supply chain networks (Hearnshaw and Wilson, 2013). We think our paper contributes to this idea in the public procurement setting. Overall, the paper makes three key contributions – methodologically, by suggesting a framework for utilising archival data in a novel manner, analytically, by comparing two fields of procurement, and through the practical implications of the findings.

## 3.2 Theory

### Frictions in public procurement

Public procurement is the purchase of goods and services by a public authority (like a government department) from companies and businesses external to the government. In many societies, public authorities are responsible for providing some goods and services (like national security, transportation, medical and educational services, and law enforcement) but do not control the means of production and therefore must engage in a transactional process with an external organisation.

In many instances, the item being purchased is a standardised, mass-produced good or service, and simple regulations on quality and price competition are sufficient to complete the transaction. Academic and practitioner interest in public procurement therefore focusses more on the procurement of large and technologically complex items that are customised and produced in small quantities as such procurement activities prove more challenging, are significant in size and scope, and have wide-ranging impacts. Procurement of such items creates a ‘megaproject’ in the public sector, a term used in project management to refer to large-scale and complex ventures which cost a billion dollars or more, take a long time to develop and complete, and can impact millions of people (Flyvbjerg, 2014).

One of the challenges to successful completion of megaprojects is the possibility of conflict arising from the involvement of multiple stakeholders with diverse interests (Bryson and Bromiley, 1993; Bourne and Walker, 2005). Since procurement is a transactional process, ‘frictions’ refer to the transaction costs associated with resolving conflicts between different stakeholders. Existing research in public procurement and project management usually attempts to explain (and resolve) conflicts between stakeholders by focussing on contracts and incentives (Bajari and Tadelis, 2001; Wu et al., 2017). Relationships between participants in the public procurement process are understood in terms of principal and agents (Schiele and McCue, 2006).

More recently, there has been an attempt in the project management literature to use institutional theory to understand the relationships, conflicts, and contradictions between project stakeholders. Biesenthal et al. (2018) discuss megaprojects in particular when calling for the use of institutional theory as “widely disparate actors, each with their own resources that are critical to the project, bring with them a set of prevailing logics that each feel are uniquely applicable to megaproject situations” (p. 49).

## **A case for institutional theory**

Institutional theory attempts to explain social structures and individual and organisational behaviour by referring to deeply-held values and beliefs, or logics. Logics are cultural and social values, norms, beliefs, regulations, traditions and symbols that guide behaviour and justify actions. More simply stated, institutional logics can be described as “the way a particular social world works” (Thornton and Ocasio, 2008, p. 101). Institutional logics persist over a long time at the organisational and societal level, influencing the behaviour of actors and agents beyond the dictates of economic incentives and resource constraints. Selznick (1957) uses the words ‘to institutionalise’ to mean “infuse with value beyond the technical requirements of the task at hand” (p. 13). Institutions thus lie beyond the realm of functionality, and institutional theory furthers our understanding of production and operations management beyond what has been possible through concepts of economic efficiency or rational decision-making (Kauppi, 2013).

Since institutional logics guide individual behaviour and support individual choices as ‘rational’, the interaction with a different logic, a different set of rules, and different beliefs of what is ‘right’ or ‘rational’ can lead to conflict. The process of institutionalisation confers value to the manner of working, and a challenge to the institutional logic is often seen as a threat to values (Scott, 2013). Competing institutional logics highlight power struggles and rivalry, and the equilibrium may involve the dominance of one logic over another or a compromise (Reay and Hinings, 2009).

Public procurement research that applies institutional theory often finds challenges in the procurement process due to conflict in institutional logics. A marketisation logic which valorises outsourcing public services for economic efficiency may be in conflict with regulations and norms previously-held by public departments (Busck, 2007; Veggeland, 2008). Stenius and Storbjork (2020) explore the conflict of market and welfare logic in procurement for health and social services in Denmark, Finland, Norway, and Sweden. Meehan et al. (2016) discuss efforts in the UK public sector for regional collaborative procurement and find that stakeholders legitimise their resistance towards collaboration by taking recourse to local-level institutional logics. The ability of institutional logics to serve as sources of resistance when the institution is under threat indicates the sacred or sanctified nature of institutions (Merton, 1939).

## **The institutional logics toolkit**

There are several ways of operationalising institutional logics for research. While the initial characterisation of institutional logics is at the level of social orders, institutional logics can also exist at other levels. Thornton et al. (2012) operationalise the study of institutional logics at the level of industry and organisations by using the term ‘field-level logics’, which are “both embedded in societal-level logics and subject to field-level processes that generate distinct forms of instantiation, variation, and combination of societal logics” (p. 148). Field-level logics can be detected by understanding resource environments, regulations, and symbolic representations like theories, frames, narratives, practices, and vocabularies of practice. Logics thus consist of a material and a symbolic component, where resource environments and regulations would fall under the material dimension and theories and vocabularies would be considered symbolic. Both are important in the emergence and evolution of field-level logics.

Resource environments usually refer to governance structure, markets, and other formal and informal networks, and these shape field-level logics by providing opportunities as well as restrictions on behaviours and practices of individuals (Rao, 1998; Scott et al., 2000). Regulation and regulatory agencies can create strong institutional environments or an “iron cage”, a term derived from Weber (1952) by DiMaggio and Powell (1983) for use in the institutional theory literature. Although the material component of institutional logics can



be powerful and significant, it is the symbolic component that is of greater interest for many researchers. For example, Mahalingam and Levitt (2007) study global construction projects and find that institutional differences lead to delays and cost overruns. However, they also find that institutional differences arising from a difference in regulations or norms are easier to resolve than cultural-cognitive differences.

To study the symbolic or cultural-cognitive elements of institutional logics, it is possible to look at theories, frames, narratives, and vocabularies of practice, of which vocabularies have been a popular topic of investigation. Vocabularies facilitate communication and convey meaning and reason to practices, and there is a historic precedent for giving importance to the study of language in institutional theory. For example, Mills (1939) describes the importance of language in conveying logic. Words are conventional linguistic expressions that can be studied as single units or as conglomerates, and a vocabulary is a system of words that is used to communicate, think, and act (Loewenstein et al., 2012). The study of words and vocabulary helps to “assess relevant features of shared understandings, professional ideologies, cognitive frames or sets of collective meanings that condition how organisational actors interpret and respond to the world around them” (Ventresca and Mohr, 2002, p. 819).

Vocabularies have been used to identify institutional logics by researchers such as Suddaby and Greenwood (2005), Meyer and Hammerschmid (2006), Jones and Livne-Tarandach (2008), and Jones et al. (2010). For example, Jones and Livne-Tarandach (2008) identify the institutional logics of architects, businesses, and government by analysing the vocabulary in manuals and documents. The core assumption in such research is that words convey meaning and help in identifying common systems of understanding and interpretation.

Vocabularies can be identified through topic modelling, an unsupervised machine learning technique that discovers latent topics within a large number of documents containing textual data (Blei and Lafferty, 2009). Topics are not pre-defined and the aim of topic modelling is to find the latent characteristics of texts. DiMaggio et al. (2013) describe topic modelling as “a statistical model of language” (p. 577) because the method involves calculating probabilities of word occurrences within documents. A ‘topic’ is a list of words that occur together, and a document can be decomposed into topic proportions based on the words it contains. Topic proportions can be used to assign topics to documents which allows efficient analysis of large bodies of text with minimum researcher subjectivity, making it often more desirable than its more commonly used qualitative counterpart, thematic coding (Valdez et al., 2018).

Recently, topic modelling has been used in conjunction with institutional theory. For example, Jha and Beckman (2017) study the emergence of charter schools in California and use topic modelling to identify and compare field-level discourse (or institutional logics) with organisational logics. Hannigan et al. (2019) review topic modelling as a method in management research and

note its utility in developing inductive classification systems and identifying meaning structures from textual data.

### **Potential comparison of procurement processes**

At the very outset, we chose to examine defence procurement and whether participants differ in their language and vocabulary choices. We assumed this would be a productive approach for two reasons. Firstly, the military is one of the earliest forms of organisation or institution in societies and has deeply rooted institutional logics, to the extent that the military sometimes appears anachronistic in modern societies (Segal and Segal, 1983). Secondly, the departments of defence in many countries are staffed by both military and civilian bureaucrats, and we wanted to find out if they have different logics even as they exist within the same organisation. This has been the motivation for some of the research on institutional logics in the military sector, like Hyvonen et al. (2009) and Batora (2009).

Additional positions in procurement research suggest that defence operates differently from other sectors of the economy (Edler and Georghiou, 2007; Mowery, 2012). The reasons include monopolistic demand, few suppliers and system integrators, and a preference for domestic suppliers. In contrast, project management practices (including training) can be shared across government departments. For example, Caldwell and Howard (2014) discuss contractual arrangements in the defence sector and suggest applicability to other limited and oligopolistic markets. Since our study focusses on identifying differences in logics between project partners, we can compare a defence department working on defence projects against a non-defence department dealing with its own projects. We wanted to explore the extent to which the defence department might differ from a non-defence department. We chose transport as the comparison case and explain the choices in the next section.

## **3.3 Method**

### **Empirical context**

In order to avoid differences in institutions because of nationality or culture, we confine our empirical work to a single country, the UK. At any point in time, the UK government's ministries and departments are engaged in several procurement projects. Some of these purchasing activities involve the procurement of large and technologically complex items, and we chose to focus on these projects because of their magnitude and non-standardised nature. A consolidated database of complex products in the UK is the *Government Major Projects Portfolio* (GMPP).

This research began in September 2018 and used the latest edition – GMPP 2018 – to identify relevant procurement projects. The selection criteria were: (a) the project included a significant procurement component (as opposed to,

for example, the implementation of a new policy), (b) involved the manufacturing sector (and not ICT systems or services<sup>1</sup>), and (c) had a sufficiently long project history (fifteen years or above). Two defence projects were identified: the Queen Elizabeth programme (procurement of aircraft carriers for the Royal Navy) and Armoured Cavalry 2025 (the procurement of armoured fighting vehicles for the British Army). Among the non-defence projects in GMPP, we found two from the Department for Transport that matched our selection criteria: the Intercity Express Programme (procurement of a fleet of long-distance intercity trains for the east coast and western routes), and the Thameslink Programme (procurement of commuter trains for the Thameslink route running through London). Thus, defence and transport became our sectors for comparative study.

All four projects have been reviewed by the National Audit Office (NAO) – an independent UK body that scrutinises government spending for the UK parliament – and parliamentary select committees like the Committee of Public Accounts, Defence Committee, and Transport Committee. A wide variety of individuals and organisations interested in and involved with the procurement provide oral and written evidence at select committee hearings. The participants belong to different organisations (MoD, DfT, Treasury, NAO, military, industry, parliament, etc.) and their organisational or institutional affiliation may guide their behaviour according to specific institutional logics. Thus, we proceed with three research questions:

1. What are the vocabularies to be found on public procurement projects?
2. Are specific vocabularies associated with specific professions, i.e., are there distinct institutional logics?
3. Are there differences between fields in the extent to which institutional logics differ amongst professions?

## **Data collection, processing, and analysis**

Multiple sources of textual data related to the selected UK government projects exist. Both the Ministry of Defence and Department for Transport have policy papers and reports related to the projects. While these documents help in developing an understanding of the projects, text analysis of parliamentary select committee hearings is the most useful means of identifying differences in institutional logics because it features conversations and debates between people belonging to different participating groups.

The transcripts of oral evidence provide a rich source of information through the questions that Members of Parliament (MPs) ask of important government and non-government actors and the answers they receive. Oral evidence allows

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<sup>1</sup>ICT and software-intensive projects are usually studied separately by researchers who study complex product systems and major projects (Davies and Hobday, 2005).

individuals to be cooperative or confrontational; written evidence provides a freer opportunity to express opinions and points of view. The unstructured nature of the texts creates challenges for analysis but provides novel insights into views and positions. When studying language and expressions of institutional logics, hearings provide a rich source of data from a large number of participants (Suddaby and Greenwood, 2005).

To collect data on the defence projects, hearings of the Defence Committee and the Committee of Public Accounts (1998 to 2019) were searched for keywords related to the projects, like ‘carrier’ and ‘armoured’. There were 36 hearings which discussed the aircraft carrier project and 18 which discussed the armoured programme. 12 hearings mentioned both programmes. Thus, data was collected from a total of 42 hearings ( $36 + 18 - 12$ ). Some hearings were dedicated to the discussion of a single project (for example, ‘The cost-effective delivery of an armoured vehicle capability’ or ‘Carrier Strike: the 2010 reversion decision’). Others were more general hearings (e.g., ‘Defence Procurement 2003’ or ‘Defence Equipment 2010’) where only parts of the hearing were dedicated to discussing the selected projects. From these documents, only the specific questions, answers, and relevant written submissions were included. This is because the empirical context is project-specific, and thus only texts discussing the projects or making reference to the projects were included.

For the transport projects, hearings of the Transport Committee and the Committee of Public Accounts (2000 to 2019) were searched for keywords related to the projects like ‘thameslink’ and ‘intercity’. In total, 20 hearings were found – 18 discussing the Thameslink programme and 9 discussing IEP (with 7 discussing both). As with the defence projects, some hearings were exclusively about procurement and the specific train programmes and were used in their entirety while only specific parts from broader hearings were included in the dataset. Appendix B.1 lists the hearings from which data was collected.

An observation in the dataset is a spoken or written text by a person in a select committee hearing. The observations were recorded at the level of speech acts (an instance of speech in a back-and-forth exchange). In the terminology of topic modelling, the text in each observation or speech act constitutes a document. For the military projects, the dataset contains 5272 observations (or documents). For the transport projects, the dataset contains 2226 observations (or documents). An important variable of analysis in this study was the ‘speaker category’ in which participants were allocated an organisation according to simple rules (Table 3.1). Some of the written evidence was authored by an organisation and it was difficult to establish an individual behind the writing. In such cases, the organisation was designated as the author of the text.

In topic modelling, the length of documents is an important factor as very short documents lead to poor model performance (Tang et al., 2014). This is because short documents do not contain enough distinctive words and make

Table 3.1: Assignment of the speaker variable

Speaker category variable	Rule for assignment of individual or organisation	Total obsv (defence)	Obsv analysed (defence)	Total obsv (transport)	Obsv analysed (transport)
mp	Member of Parliament (not including government ministers)	2591	710	1067	445
cs_dft	Civil service personnel in the Department for Transport and agencies (Network Rail, ORR, Strategic Rail Authority)	0	0	787	487
cs_mod	Civil service personnel in the Ministry of Defence	1181	459	0	0
min_dft	Ministers in the Department for Transport	0	0	49	43
min_mod	Ministers in the Ministry of Defence	338	196	0	0
industry	Business and industry executives, private listed companies	163	123	197	128
nao	National Audit Office	53	22	34	18
military	Military personnel	857	386	0	0
dft	Department for Transport (when speaker/author cannot be classified as a civil servant, military personnel, or minister)	0	0	6	6
mod	Ministry of Defence (when speaker/author cannot be classified as a civil servant, military personnel, or minister)	48	45	0	0
academic	Researcher/lecturer/professor at a university	17	15	18	13
advocacy	Advocacy or lobby groups, including charities	0	0	15	10
eu	Officials from the European Union	0	0	19	12
consultant	Consulting services company	3	3	3	1
council	Local council	0	0	3	3
cs_co	Civil service personnel in the Cabinet Office	2	2	0	0
hmt	Treasury	1	1	0	0
journalist	Journalist	1	1	1	1
min_pm	Prime Minister	1	1	0	0
scot_msp	Member of Scottish Parliament	2	1	0	0
tfl	Transport for London	0	0	1	1
thinktank	Researcher in a think tank	7	7	0	0
union	Trade unions	2	2	12	10
users	Rail user groups/ commuters	0	0	11	9
other	Not classified in any of the other categories	5	2	3	0
<b>Total</b>		<b>5272</b>	<b>1976</b>	<b>2226</b>	<b>1187</b>

it harder to discover topics within a document. Our data had several such documents – short sentences and perfunctory exchanges, which were removed. This decision is not just related to a methodological point but also influenced by the research question. Speech acts become meaningless from the point of view of the research question below a certain threshold. The threshold was 50 words for defence and 30 for transport<sup>2</sup>. For the military projects this reduced the number of observations from 5272 to 1976, and for transport, the dataset was reduced from 2226 to 1187.

## Pre-processing

The *stm* package was used for topic modelling (Roberts et al., 2014). In the first step, the text is converted to lowercase and numbers and punctuations are removed. The *textProcessor* function in the package also removes words like ‘the’, ‘a’, ‘that’ and stems words to a single form. A customised list of words (one for defence, one for transport) was used in addition to the removal of usual English stop words to remove words specific to the data like ‘chair’, ‘admiral’, ‘minister’, ‘railway’ that would not contribute to topic identification, simply because they are too common or irrelevant (details in appendix B.2). Next, documents were broken down into words and words that did not appear in more than twenty documents were discarded. An initial topic modelling was done by assigning  $K$  (the number of topics to be discovered) as five and using LDA (latent Dirichlet allocation) initialisation. A number of alternate topic models were then generated before making the final selection.

## Topic modelling

Different values of  $K$  lead to different estimations, with some models being more statistically or practically meaningful than others. Choosing  $K$  is the most challenging aspect of topic modelling and requires a combination of statistical indicators and researcher judgement. A very small value of  $K$  might force multiple topics into a single large topic, while a very large value of  $K$  might lead to meaningless fragmentation. There is a trade-off and there is no perfect value for  $K$ , as the research question also influences the choice of model. Semantic coherence scores (from *searchK* function) are plotted in Figure 3.1 and Figure 3.2 for  $K$  ranging from two to seventeen for both the defence and transport data, respectively. Lower semantic coherence scores indicate lower coherence of the topics discovered in the model.

Based on the semantic coherence scores, topic models with  $K = \{3, 4, 5\}$  were estimated for defence and  $K = \{4, 5, 6, 7\}$  for the transport data. The topics discovered from each model were manually checked for coherence and meaning. In defence, topics were hard to identify with  $K = 5$  and the model appeared

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<sup>2</sup>Thresholds were decided by scanning observations by increasing length and deciding where (approximately) a piece of text contained words that could contain a coherent topic. Speech acts related to the defence projects were more verbose and therefore have a higher threshold.

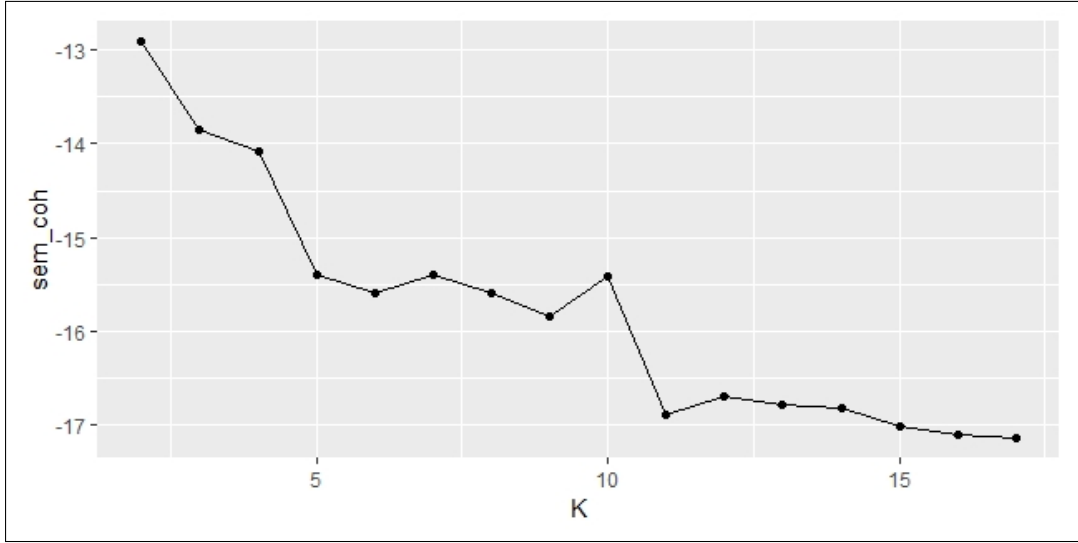


Figure 3.1: Semantic coherence scores for different values of  $K$  (defence)

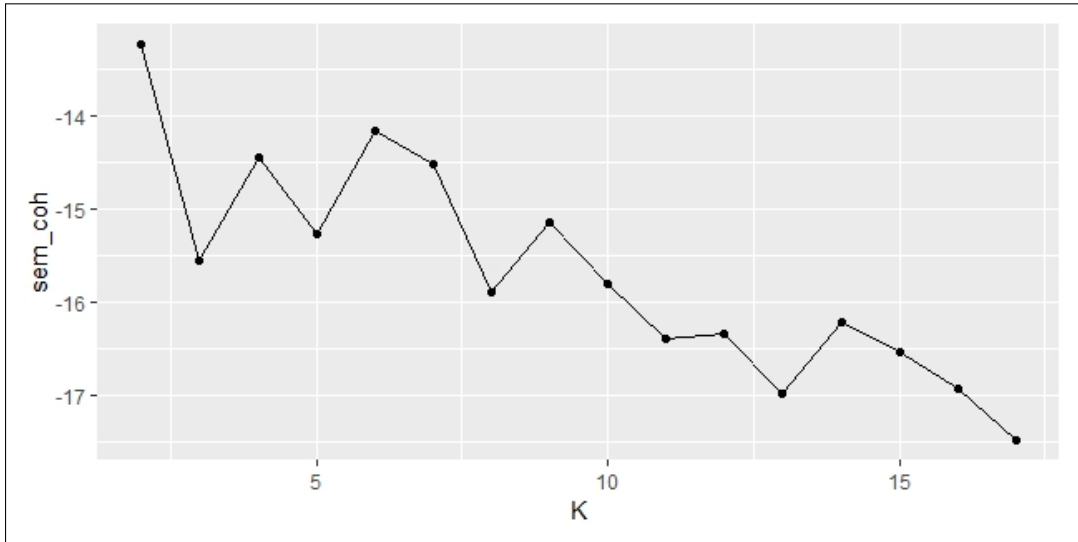


Figure 3.2: Semantic coherence scores for different values of  $K$  (transport)

to be overfitted (i.e., it appeared that the data was incapable of holding five latent topics). Figure 3.1 also echoes this by showing a large drop in semantic coherence scores from  $K = 4$  to  $K = 5$ . Topic 1 and Topic 4 in this model appeared broadly similar. All topics in the model with  $K = 4$  could be coherently labelled and easily distinguished from each other. The model with  $K = 3$  lacked a topic on military operations and capability that was easily identified in the other two models, and which also seemed relevant to the context. Therefore, the model with three topics was also rejected. The final model was estimated for four topics and is described in detail in the next section.

For the transport projects,  $K = 7$  led to an overfitted model and produced many non-coherent topics. With  $K = 6$ , all the topics could be labelled and

distinguished from each other. With  $K = 5$  and  $K = 4$ , there were some ambiguous topics combining very diverse vocabularies. Therefore, the final model was estimated for six topics, described in the results section.

### Assignment of documents to topics and inter-coder agreement

At the end of topic modelling, each document is assigned a topic proportion, which is the share of different topics that make up the document. The dominant topic is usually identified based on the highest topic proportion. Manual investigation of the assignment of documents to topics is important to ensure accuracy of the results (Kobayashi et al., 2018). Therefore, a topic assignment task was designed which asked human coders to identify the most relevant and least relevant topic from a set of three options. The task involved twenty observations, selected from both defence and transport data (stratified random sampling to ensure all topics were present). Inter-coder agreement between the machine, the first author, and another independent human coder was calculated with Fleiss’s kappa formula (Fleiss, 1971). A satisfactory level of coder agreement was found in both topic models (Table 3.2), indicating the reliability of the topic assignment performed by the machine.

Table 3.2: Results of inter-coder agreement

Model	Agreement on ‘most appropriate’ topic	Agreement on ‘least appropriate’ topic
Defence topic model	0.611	0.712
Transport topic model	0.901	0.662

## 3.4 Findings and discussion

### Topic identification and labelling

#### Defence projects

There were four distinguishable topics in the defence corpus of texts. Table 3.3 lists the top seven words associated with each topic, along with the proportion of documents within the topic containing these terms. The *stm* package also provides frequent and exclusive terms to help label each topic. Themes and topic labels are provided in columns 5 and 6. The final column gives the number of documents in the corpus assigned to the topic.

Topic 1 is composed of a vocabulary associated with industrial strategy, project management, and delivery. Observations associated with this topic discuss industrial partners (companies) who work on the projects. The word ‘alliance’ refers to the alliance approach strongly associated with both projects because their development required system integrators and combined capacity and expertise of different component manufacturers. An exemplary text is provided below (with authors’ emphasis):



Table 3.3: Identification of topics (defence)

Topic	Words with high probability	Probability of word occurring in documents assigned to topic	Frequent and exclusive words in topic (FREX)	Themes	Topic label	No. of obsv. assigned to topic
1	industry	0.44	alliance, assessment, company, contract, industry	industrial activities, project management and delivery	project management	312
	work	0.43				
	project	0.38				
	defence	0.38				
	contract	0.35				
	cost	0.32				
	assessment	0.21				
2	operation	0.59	armed, capability, deploy, forces, operation	operational capability & military support	operational capability	218
	need	0.35				
	forces	0.30				
	system	0.29				
	support	0.27				
	fres	0.18				
	capability	0.12				
3	plan	0.30	fighter, french, joint, product, strike	strategic partnerships & development of equipment	strategic choices	112
	partner	0.30				
	strike	0.26				
	develop	0.26				
	requirement	0.24				
	state	0.21				
	equipment	0.15				
4	make	0.30	actual, know, question, quit, answer	decision-making & accountability	accountability	1334
	time	0.29				
	decision	0.25				
	just	0.23				
	cost	0.23				
	year	0.22				
	know	0.21				

*“I think it is worth noting that from the outset, even when this competition was run essentially under the heading of ‘prime contractorship’, both of the competing companies, Thales and BAE Systems, put forward teams of companies to respond to that competition. Both sides recognised that it would require a number of companies to come together, both in terms of skills and capacities, to respond to this project.”*

*(Mr Chris Geoghegan, CEO BAE Systems; from ‘Future Carrier and Joint Combat Aircraft Programmes’, 21 December 2005, Q13)*

Topic 2 has been labelled as ‘operational capability’ because the words describe military operational capacity. The observations associated with this topic stress on operational capacity and the role of the equipment being procured (armoured vehicle, aircraft carrier) in delivering capacity. The vocabulary contains words like ‘deploy’, ‘forces’, ‘operation’, and ‘capability’. Unlike the previous topic which focusses on industries, this topic focusses on the armed

forces.

*“I am in danger of repeating what he said but FRES is required as a replacement armoured vehicle in the armoured brigades and to equip the medium weight brigades, now known as the three mechanised brigades. It is required to enable the armoured brigades to fight conventional wars, rather as we saw in Telic 1, and it is required to enable the mechanised brigades to both support the armoured brigades with what we in the Army would say a manoeuvre support brigade, and also to be deployed in peace-keeping and peace enforcement operations.”*

*(Lt Gen Andrew Figgures, Deputy Chief of Staff (Equipment Capability) Ministry of Defence; from ‘The Army’s requirement for armoured vehicles: the FRES programme’, 21 February 2007, Q43)*

Topic 3 is characterised by the vocabulary used to discuss partnership and participation of different states in the development of equipment, particularly the Joint Strike Fighter programme with the US and discussions on cooperation with France on the carrier project. Therefore, this topic has been labelled as ‘strategic choices’.

Topic 4 contains the vocabulary used to discuss decision-making and accountability. Some observations highly associated with this topic include statements like ‘who is responsible’, ‘how were decisions made’ and whether someone ‘did/did not know’ about the decisions being made. A possible explanation for a large number of observations being assigned to this topic (1334 of 1976) may be the nature of select committee hearings which examines government decision-making and seeks to establish accountability. An illustrative exchange is provided below. It also provides a glimpse of the nature of exchanges, where questions do not lead to direct or relevant answers, and participants seem to be talking past each other.

*Ursula Brennan (Permanent Under-Secretary Ministry of Defence): We have acknowledged that there were failings in our procurement of armoured fighting vehicles. Yes, we do acknowledge this.*

*Mr Richard Bacon (MP): Who has paid the price for that? Who has paid the penalty for that scale of error? Because for most of this decade – although we have had an enormous financial crunch since 2008 or late 2007 – it was a period of rising government spending. It is a huge failure. Who is paying the penalty for that? Is anyone?*

*Ursula Brennan: The reasons –*

*Mr Bacon: Apart from the soldiers on the ground obviously, who has paid the penalty for this failure in the Ministry of Defence?*

*Ursula Brennan: The reasons –*

*Mr Bacon: No, no, my question is who? The answer must be a person or no person.*

*Ursula Brenna: The reason why I wanted to say the reasons is because the reasons why certain programmes were stopped or cancelled were to do with decisions that were taken, in some cases about the procurement routes, between Ministers and officials at the time about the way it was chosen to procure –*

*Mr Bacon: You are answering a question that is not the question I asked. You are giving me an explanation of how we reached this position through decisions having been taken. Plainly, some decisions must have been taken for us to end up in a particular position. There must have been bad decisions for us to end up in a particularly bad position such as this one. My question is who has paid the penalty for this in the Ministry of Defence? It's a simple question. Who?*

*(The cost-effective delivery of an armoured vehicle capability, 9 December 2011, Q23-27)*

## **Transport projects**

There were six distinguishable topics in the transport corpus. Table 3.4 lists the top seven words associated with each topic, along with the proportion of documents within the topic containing these terms. Frequent and exclusive terms, themes, topic labels, and the number of documents in the corpus assigned to the topic are also provided.

Topic 1 conveys a vocabulary about train manufacturing, especially the choice of British manufacturing by containing words like ‘derby’ (a place in Britain where a manufacturing facility is located), ‘bombardier’ (one of the competing companies based in the UK), and ‘jobs’. Observations associated with this topic discuss the choice of the train manufacturer in rolling stock procurement contracts for Thameslink and Intercity Express programmes.

*“We have declared as part of the preferred bidder announcement that we would create 2,000 jobs in the UK, of which around 1,400 would be the building of depots and the ongoing maintenance for around 30 years, which probably could be the same as Bombardier, I would guess, and another 600 in the UK supply chain, which would involve around 300 at our facility in the north-east of England.” (Mr Steve Scrimshaw, Managing Director Siemens plc; from ‘Thameslink rolling stock procurement’, 16 December 2011, Q49)*

The choice of Siemens, a German train manufacturing company, over Derby-based Bombardier in 2011 for the Thameslink programme led to several statements on the effect of procurement choices on the manufacturing sector. Topic 3 is related to this episode. It has been labelled as ‘EU procurement directives’ because the observations associated with this topic heavily mention European law on public procurement and awarding of contracts.

Table 3.4: Identification of topics (transport)

Topic	Words with high probability	Probability of word occurring in documents assigned to topic	Frequent and exclusive words in the topic (FREX)	Themes	Topic label	No. of obsv. assigned to topic
1	procure	0.85	manufacture, bombardier, siemens, derby, jobs	choice of manufacturer, industrial jobs	manufacturing	128
	bombardier	0.40				
	manufacture	0.32				
	siemens	0.31				
	supplier	0.29				
	bidder	0.28				
	design	0.21				
2	year	0.38	inform, company, responsibility, agreement, fiasco	management issues, information	project management problems	55
	clear	0.24				
	last	0.24				
	issue	0.22				
	committee	0.18				
	company	0.16				
	term	0.16				
3	procure	0.76	contract, public, economic, EU, law	contract award, EU law, procurement directives	EU procurement directives	83
	contract	0.45				
	public	0.29				
	state	0.29				
	value	0.24				
	award	0.16				
	direct	0.14				
4	cost	0.26	question, cost, budget	costs, differences in payments, budgeting over time	project costs	315
	question	0.25				
	time	0.23				
	now	0.16				
	differ	0.15				
	like	0.15				
	case	0.13				
5	delivery	0.46	complex, bridge, management, work, delivery	project complexity, planning and delivery	project complexity	347
	project	0.42				
	work	0.35				
	plan	0.27				
	need	0.23				
	network	0.23				
	management	0.19				
6	new	0.44	passenger, crowd, improve, route, service	passenger growth, capacity, improvements to service	capacity and service	259
	passenger	0.41				
	service	0.37				
	franchise	0.29				
	operator	0.28				
	line	0.27				
	electrification	0.16				

Topic 2 relates to project failures and project management problems. It is distinct from Topic 4 and Topic 5 which identify a vocabulary on project costs and project complexity, respectively. Observations associated with Topic 4 discuss costs and budgeting for lengthy projects over time. Topic 5, on the other hand, is based on a vocabulary that is used to discuss project complexity, planning, delivery and other associated works. The following exchange illustrates how closely the topics are related but still characterised by different vocabularies (it also demonstrates how questions using a specific vocabulary can be continually answered with a different vocabulary):

*Karin Smyth (MP): If electrification doesn't go ahead, how much of that money is wasted?*

*Mark Carne (Chief Executive, Network Rail): Well, I can't give you an answer to that now, because it includes a number of different aspects of the work, including improving the track and the system, as well as preparation works for electrification. So I'd be happy to come back to the Committee with a response on that breakdown; I don't have it to hand. [**Topic assigned: project complexity**]*

*Karin Smyth: That would be helpful. I tried to ask the Minister this question in Westminster Hall. In the work that you are doing from now to some period in 2024, which we have not been able to determine — how much will you spend on those sections that are not to do with electrification? We understand the signalling problem, but what we don't have clarity on is if this does not go ahead, how much money is being spent preparing for electrification now and up to 2024 that may not be needed by electrification, given that we get all the benefits by not electrifying? [**Topic assigned: project costs**]*

*Mark Carne: As I said, I will come back to you with a breakdown of it. There's a significant amount of work that needs to be done in the Bristol area, including massive resignalling jobs — which we're continuing to do, and track work, particularly around Bristol Temple Meads and the diamond at Bristol Temple Meads that we have to do, and four-tracking at Filton Bank. So there's a lot of work that we need to do— [**Topic assigned: project complexity**]*

*Karin Smyth: You understand what the Committee's concern is. Given the amount of money that this has cost so far if this is not going to happen, the Committee needs to know sooner rather than later about the difference between work that is essential for signalling and so on, and work that is purely allocated to electrification, which is why we'd like to understand both what's been spent so far and what is likely to be spent in the next few years. Thank you. [**Topic assigned: project costs**]*

*(Modernising the Great Western Railway, 3 March 2017, Q31-33)*

Topic 6 contains words that relate to passenger numbers, overcrowding, and capacity and improvements to service through electrification of lines and new

franchises for operating passenger services. The topic is labelled ‘capacity and service’ as it relates to passenger service.

### Association of topics with speaker categories

In both the defence and transport topic model, each observation was assigned a topic based on the highest topic proportion. Since each observation is associated with a speaker category or group (Table 3.1), it is possible to determine the share of observations assigned to different topics for each group. Figure 3.3 shows the distribution of the four topics for six groups in the defence sector: NAO, MPs, ministers in the Ministry of Defence (min\_mod), military personnel, civil servants in the Ministry of Defence (cs\_mod), and the industry. Figure 3.4 does the same for transport, where the groups are: NAO, MPs, ministers in the Department for Transport (min\_dft), civil servants in the Department for Transport (cs\_dft), and the industry. The associated data is provided in Appendix B.3.

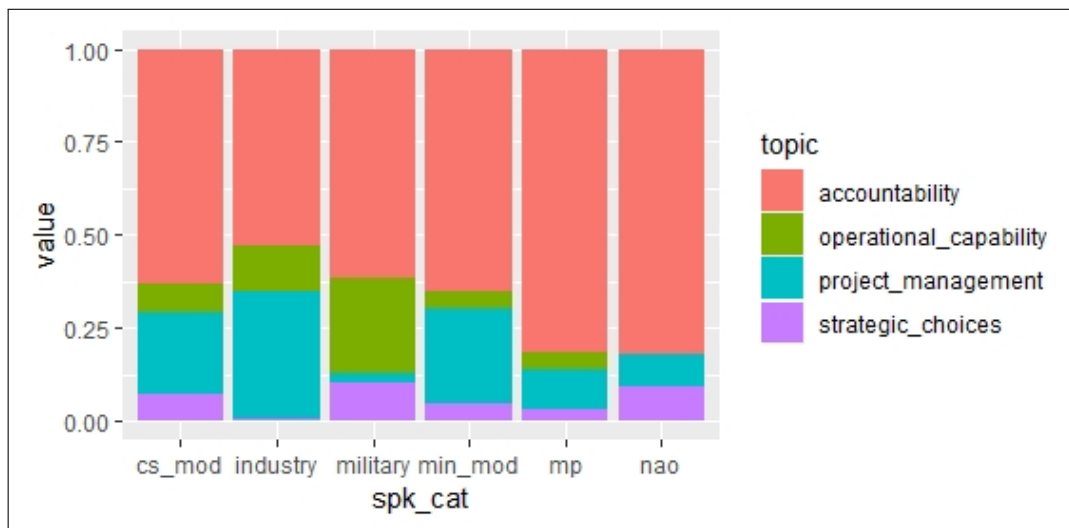


Figure 3.3: Topic distribution for key speaker categories (defence)

The topic distribution in a speaker category or group is an indicator of the probability that texts by an individual in the group will use certain vocabularies. For example, in Figure 3.3, of the statements made by MPs, 81.5% use the vocabulary of ‘accountability’, 10.8% use the vocabulary of ‘project management’, 4.8% use the vocabulary of ‘operational capability’, and 2.9% use the vocabulary of ‘strategic choices’. This distribution is different from the probability distribution over topics for military personnel, where the observations are distributed with 61.4% in ‘accountability’, 2.6% in ‘project management’, 25.6% in ‘operational capability’, and 10.4% in ‘strategic choices’.

The figure suggests differences in topic distribution between speaker categories. Groups exhibit preferences for certain vocabularies. Some of these associations are obvious – in the defence topic model, military personnel have a higher share of texts on ‘operational capability’ than other groups, and industrialists have

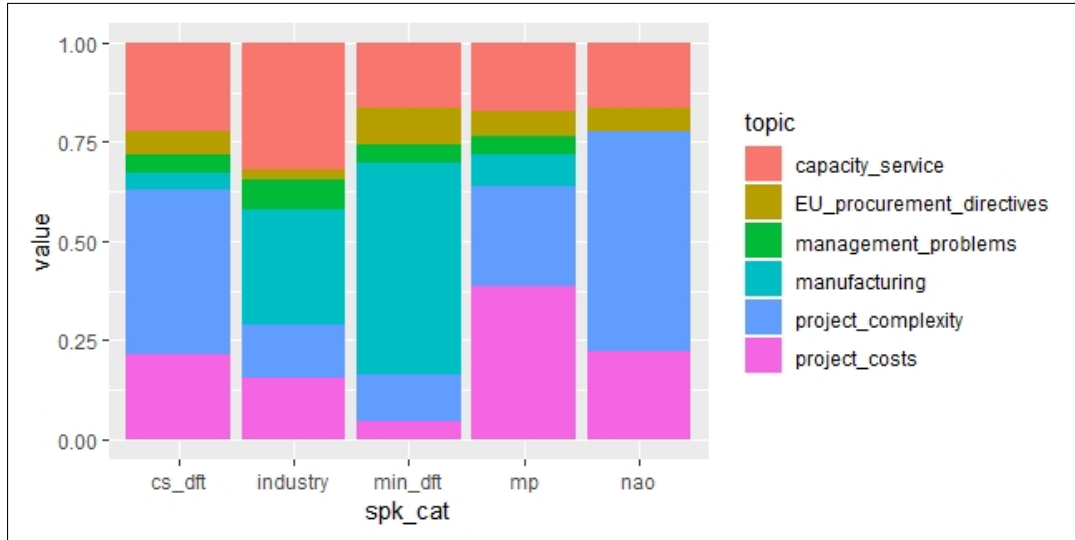


Figure 3.4: Topic distribution for key speaker categories (transport)

a higher share of texts on ‘project management’ than other groups. Obvious and intuitive results like these help to validate the topic modelling approach adopted in this study.

Figure 3.4 indicates that civil servants in the DfT are most likely to use the vocabulary of ‘project complexity’ (41.5% of cs\_dft) while MPs are more likely to use the vocabulary of ‘project costs’ (38.6% of mp). ‘Manufacturing’ is a preferred topic for the industry (29% of industry). There is also a preference for ‘capacity and service’ (32% of ‘industry’), perhaps because it can be used to present the business case for projects. Industrialists are more likely than any other group to mention capacity and service, closely followed by civil service personnel at the DfT.

## Test of differences

Differences in vocabularies reflect differences in thoughts, priorities, beliefs, and thus institutional logics of the different professional groups. The differences are especially interesting to observe within a corpus made from select committee hearing evidence since one would assume that a conversation between stakeholders is less likely to allow different vocabularies to be expressed. If we were to interview members of different groups (military, civil servants, industry executives, MPs), we might be more likely to find differences in vocabulary as individuals will only be facing a neutral researcher. But our data shows that even when talking to each other, different groups have different likelihoods of using specific vocabularies<sup>3</sup>.

<sup>3</sup>We checked the topic distribution of questions (usually asked by MPs) against all answers to see whether differences between groups was being driven by the specific questions they get asked based on their areas of expertise. However, the topic distribution among ‘question texts’ and ‘answer texts’ was also very different. Therefore, we are confident that vocabulary is a matter of choice and not an exact reflection of the question asked.

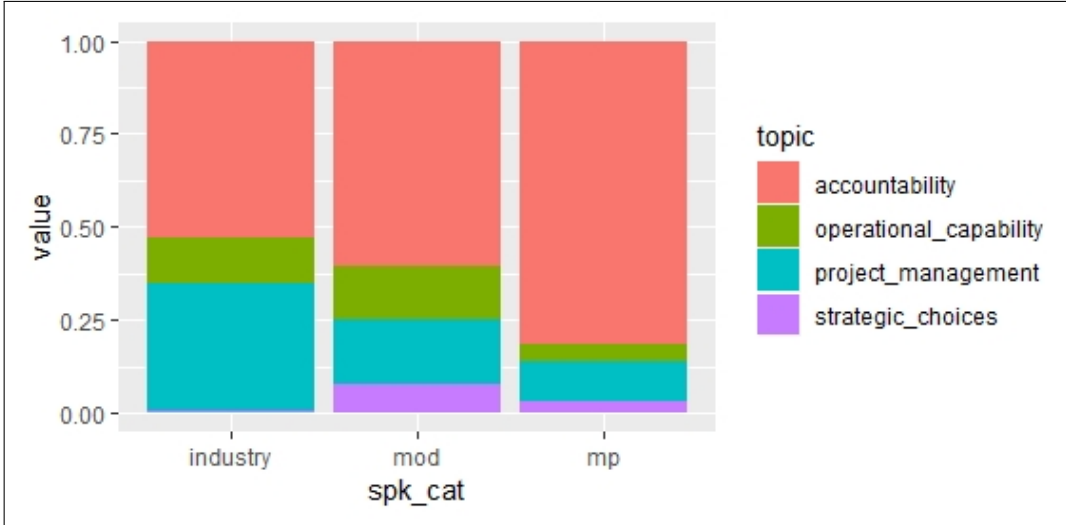


Figure 3.5: Topic distribution for three key groups (defence)

Table 3.5: Test of differences in topic distributions among different groups (defence)

	Industry-MoD	Industry-MP	MoD-MP
<b>Chi-square statistic</b>	25.644984	63.445	96.399
<b>Degrees of freedom</b>	3	3	3
<b>p-value</b>	$1.13 \times 10^{-5*}$	$0*$	$0*$
<b>Topic 1</b>	$6.5 \times 10^{-7*}$	$6 \times 10^{-12*}$	$0.0001*$
<b>Topic 2</b>	0.0496	$1.2 \times 10^{-3*}$	$8.10 \times 10^{-11*}$
<b>Topic 3</b>	$3.8 \times 10^{-3*}$	0.1708	$0.0001*$
<b>Topic 4</b>	0.11	$2 \times 10^{-12*}$	$0*$

Figure 3.5 provides the topic distribution of three key groups in the defence corpus – Ministry of Defence (comprising of civil servants, defence ministers, and military personnel), MPs, and the industry. Chi-square test for difference has been conducted for each possible pair (industry-MoD, industry-MP, MoD-MP) and the results are presented in Table 3.5. The null hypothesis is that there is no difference between the two groups in topic assignment (i.e., there are no significant differences in vocabulary preference and, therefore, institutional logic). Since multiple hypotheses are being tested for each pairing, Bonferroni corrections have been applied (thus, the hypotheses are tested at  $\alpha = \frac{0.05}{4}$ ), and an asterisk indicates that the null hypothesis was rejected.

Figure 3.6 provides the topic distribution of three groups (department, industry, MPs) in the transport corpus. Table 3.6 presents the results of the chi-square test of differences in the likelihood of utilising a specialised vocabulary (or topic) between two speaker categories. As before, the null hypothesis is of no difference between two groups in vocabulary usage and topic preference (Bonferroni correction means that the hypotheses are tested at  $\alpha = \frac{0.05}{6}$ ).

From Tables 3.5 and 3.6, we find that members of the government department (MoD, DfT), members of the industry, and members of parliament use different



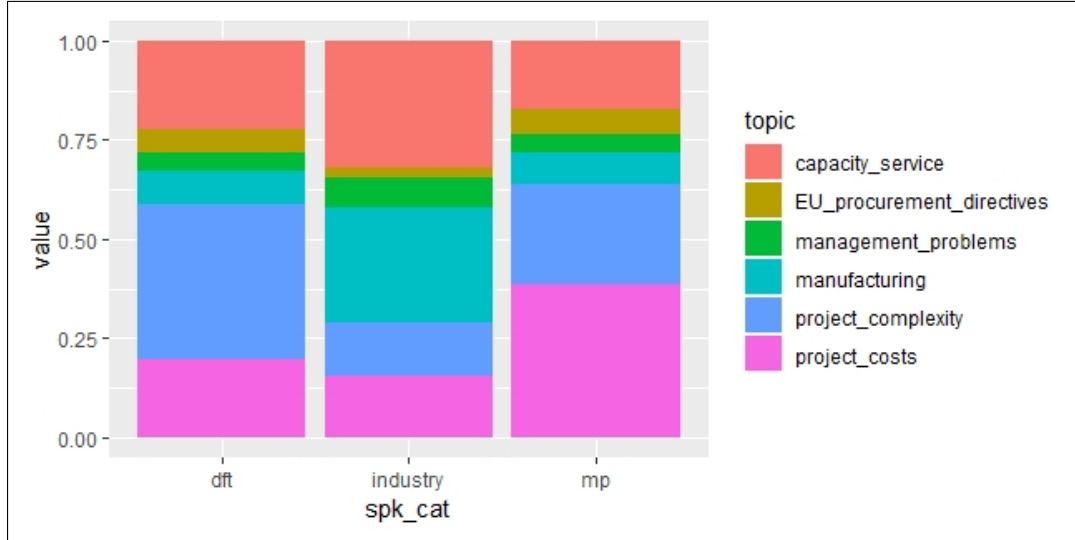


Figure 3.6: Topic distribution for three key groups (transport)

Table 3.6: Test of differences in topic distributions among different groups (transport)

	Industry-DfT	Industry-MP	DfT-MP
<b>Chi-square statistic</b>	64.8598	69.8184	47.6747
<b>Degrees of freedom</b>	5	5	5
<b>p-value</b>	$1 \times 10^{-12}$ *	0*	$4.14 \times 10^{-9}$ *
<b>Topic 1</b>	$2.34 \times 10^{-10}$ *	$9.25 \times 10^{-10}$ *	0.96363
<b>Topic 2</b>	0.0152	0.0107	0.766
<b>Topic 3</b>	0.0869	0.0818	0.93032
<b>Topic 4</b>	0.0282	$1.15 \times 10^{-6}$ *	$6.5 \times 10^{-11}$ *
<b>Topic 5</b>	$4.21 \times 10^{-8}$ *	$5.24 \times 10^{-3}$ *	$3.9 \times 10^{-6}$ *
<b>Topic 6</b>	0.019	$3.6 \times 10^{-4}$ *	0.0689

vocabularies when discussing projects, and that these differences are statistically significant (being very unlikely to have arisen by chance). Conducting a conversation with different words and vocabularies can make communication difficult. In our specific case, we find evidence of participants talking past each other, which is unhelpful in any context, not least during discussions about the progress and management of a major public project. Vocabularies are an indicator of institutional logics and different vocabulary preferences suggest institutional differences between key stakeholders. The implication of these institutional differences is discussed in the next section.

## 3.5 Conclusion

### Contribution and implications

Topic modelling of texts from both military and non-military public procurement projects reveals a variety of topics and vocabularies. In defence, there are distinct vocabularies related to military operational capability, strategic

inter-state partnership, project management from a system-integration point of view, and regarding accountability or responsibility for projects. In transport, we observe topics like rail service and capacity, project costs, and project complexity. There are also discussions related to the rolling stock manufacturing industry, European procurement laws, and project management failures, which are perhaps motivated by the peculiarities of the Thameslink and Intercity projects<sup>4</sup>.

We have followed existing research, like Suddaby and Greenwood (2005) and Jones and Livne-Tarandach (2008), in assuming that words and vocabularies express thoughts, intentions, and beliefs and therefore serve as an indicator of institutional logics. In this study, we find that the different groups participating in the procurement process have preferences for specific vocabularies, and there are differences between the groups regarding choices of vocabulary. For example, military personnel tend to mention operational capability more than others in the military field. In the field of public transport, MPs in select committees are more likely to speak with the vocabulary of project costs while DfT ministers and civil servants are more likely to use the vocabulary of project complexity. The associations are largely intuitive which furthers the case for using topic modelling as a valid research method to identify institutional differences.

We find that members of the government department (MoD, DfT), members of the industry, and members of parliament use different vocabularies when discussing the same procurement projects, even when they are in the same conversation, exhibiting institutional differences. Are these differences incommensurable? We are not sure. On the one hand, a difference in vocabulary can be addressed by a suitable translation mechanism. Project managers could consider intermediation strategies. For example, there could be an investment in professional intermediary services (like client or supply managers) or investment in platforms that can be used by project partners coming from different institutions. The management efforts could involve the creation of a shared vocabulary to make conversation and cooperation easier. On the other hand, vocabulary differences reflect cultural-cognitive institutional differences which are known to be difficult to resolve (see Mahalingam and Levitt, 2007). Additionally, large public projects involve institutions that are often traditionally opposed to each other – consider the government department trying to deliver the project (an executive branch) and the MPs in select committees who are scrutinising the project delivery for value to the taxpayer and the public (members of the legislature). Not sharing vocabularies might be just one manifestation of differences.

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<sup>4</sup>The selection of Siemens for the rolling stock contract in Thameslink led to a strong reaction about the demise of British manufacturing even as the government defended the decision by citing the need to comply with EU procurement directives. IEP was affected by delays in the western line electrification and the franchise problems of the West Coast Main Line and therefore project failures was a topic of discussion.

We find some interesting differences between the *extent* of vocabulary differences in defence and transport. From Table 3.5 and 3.6 we observe that the proportion of topics on which groups differ is greater in defence than transport. In all three pairs, the null hypothesis of no difference in vocabulary usage was rejected more often in defence than transport. The difference between department-MP vocabularies is most striking – in defence, the two groups have differences in vocabulary usage for all the topics, whereas this only happens in a third of the topics in transport. We interpret this as an indication that institutional differences and conflict due to institutional differences are more likely in defence projects than transport projects.

There may be concerns about the generalizability of this comparison as the projects may not be representative of their fields. We admit that all four projects have been controversial (the status of their development and confidence over delivery has fluctuated over project lifetime), making them seem idiosyncratic. However, the objective of this paper is to compare the intensity of conflict within two fields. The only criticism of the generalizability of these results which we can anticipate is that the selected defence projects were particularly complex while the transport projects were less prone to controversy or conflict. However, given the nature of all four projects, that seems unlikely to be the case.

## **Limitations and future research**

While our study shows that there exist differences in the vocabulary used by different groups involved in the public procurement process, we are able to create only a limited picture of the implication of these differences. Differences in vocabulary can create misunderstandings and delays in securing agreement. However, our evidence from the analysis of transcripts does not show how differences then lead to actual conflicts between groups. We think interviews could help us answer this question. As it is, there is not enough research on public procurement from an operations management perspective and our study makes a case for further research on this topic. Essentially, this research has identified the pre-conditions of differences in perspective that can lead to frictions and conflict in public procurement.

Another direction of future research lies in creating more nuanced distinctions between the currently proposed speaker categories, especially MPs and industry. For example, would vocabulary choices differ with differences in political parties or the tiers to which industrial partners belong to? Would vocabularies differ because of past affiliations – civil servants who have previously worked in the industry, MPs who have previously worked in the military, and so on? We think these are interesting questions which merit investigation (not least because of the presence of a ‘revolving door’ amongst senior executives), but these questions lie outside the scope of the present study.

This study is an initial step towards a more detailed investigation of insti-

tutional logics which operate in a public procurement process. Our study demonstrates that participants of a public project can have very different vocabularies. The research methodology of this paper – text analysis and topic modelling – is easily adaptable and transferable to other contexts. Data collection and analysis can be executed with fairly limited resources in an effective manner. In the face of resource constraints, this paper exemplifies a rigorous and efficient approach to the study institutional logics, which we suggest is an important contribution in itself.

## Notes about military-civil differences

The main finding from this research is about the existence of institutional differences in the procurement landscape involving defence and public transport procurement projects. Institutional heterogeneity is demonstrated through different vocabulary preferences amongst the stakeholders in the procurement process. The level of institutional heterogeneity, if measured as the share of topics where preferences between two groups differ, is greater in defence than in public transport (Table 3.7). Since institutional differences are associated with challenges and conflicts (see Mahalingam and Levitt, 2007; Scott, 2013; Meehan et al., 2016), this finding suggests that the likelihood of conflict is greater in the field of defence than in public transport.

Table 3.7: Level of institutional heterogeneity (number of topics where null hypothesis was rejected in Tables 3.5 and 3.6, divided by total number of topics)

Pairing	Military	Civilian
Department - Industry	0.50	0.33
MP - Industry	0.75	0.67
Department - MP	1.00	0.50

It may be asked whether the texts from military personnel are responsible for driving the difference between the defence department and other groups in the field of defence. After all, the composition of the MoD includes both military and civilian officials, unlike the DfT. However, the data does not indicate this – chi-square tests and significant p-values follow the same pattern even when military personnel are excluded from the definition of MoD.

Going beyond the topic modelling exercise, it is possible to glean several interesting observations from the parliamentary select committee hearings related to the overarching thesis question ‘is defence different?’. In the world of practice, there seems to be an appetite for giving greater recognition to the technological complexity of civilian public procurement and adopting some elements of defence procurement. This can be seen most clearly in the Thameslink rolling stock procurement. Price competition was severely criticised as ‘neo-liberal’. A piece of written evidence commented on the problems with using lowest price to select the preferred bidder in the case of non-standardised products like railway rolling stock (Transport Committee, 2011, p. 55-56). Civilian projects, on account of their non-standardised nature and technological complexity, could share some characteristics usually associated with defence projects, like the lowest price not being appropriate for market clearing or the existence of objectives beyond least cost.

Some aspects of defence procurement policy are considered desirable in civilian contexts. For example, there is a greater awareness in the Ministry of Defence about the industrial implications of its procurement activities than the Department for Transport. This gets raised in the discussions in parliamentary

committee hearings. For example, in the Transport Committee hearing following the selection of Siemens for the Thameslink contract (and the furore over neglecting Derby-based Bombardier), reference was made to the inclusion of industrial policy as a component of the award process in European procurement directives (Transport Committee, 2011, Q13). In the same hearing, the Transport Secretary was asked whether it would be appropriate “to think of train manufacturing as a national critical industry in the same way as we do the defence industry” (Transport Committee, 2011, Q106).

On the matter of contracts, where it is assumed that “the cost-plus basis of the defence equipment development and procurement system will have little relevance to the civilian sector” (Rothwell, 1984, p. 329), there is evidence to the contrary as governments seem to enter into incomplete and complex contractual arrangements to procure civilian technologies like trains. In a hearing of the Public Accounts committee in 2014, the question of risks being taken by the DfT was raised (see Committee of Public Accounts, 2014). The DfT had signed contracts where if passenger demand for services was less than predicted, DfT would have to cover any financial shortfall for the train manufacturer. This, unfortunately, came to pass in the Intercity Express Programme. Agility Trains Limited (a Hitachi-led consortium) won the contract to finance, build, and maintain rolling stock for the Great Western and East Coast mainline in 2009 (contract signed in 2012). The contract was not a fixed-price contract but involved the DfT paying Hitachi for trains that would be made available over a period of 27.5 years. However, delays in the electrification programme (which began to occur in 2015) meant that many of Hitachi’s new rolling stock could not be used by the train operating companies in 2017-2018. However, DfT still paid Hitachi for the trains that sat idle.

Essentially, for both Thameslink and IEP, the DfT signed ‘an availability contract’ which is found in the defence sector as well. This is illustrated by the following remarks by Sir Amyas Morse, the Comptroller and Auditor General, in 2013.

“I can see that you [civil service personnel from DfT] have a very complicated deal structure for rolling stock, with what is essentially an availability contract. I am familiar with that from seeing something like it in the defence industry, where you say, ‘It’s too complicated for us to get involved. We expect you to have something available for use and we will pay you for having it available for use,’ and you set it up like that.” (*Progress in the Thameslink Programme, 19 June 2013, Q155, emphasis added*)

Thus, complex risk-sharing arrangements are to be found in non-military public procurement as well. The observations suggest that defence is not different and that it may be more useful to organise products on a hierarchy of complexity rather than a sectoral classification, perhaps along the lines of Walker

et al. (1988), which argues that some defence and civilian product systems may be similar because of their complexity.

Moreover, parliamentary scrutiny of both defence and public transport projects expresses an interest in questions of accountability and cost-benefit analysis. In the case of the aircraft carrier, doubts are expressed about its purported utility repeatedly during the project's development, in parliamentary committee hearings (Committee of Public Accounts, 2011, Q117-Q118), challenging the assumption that defence projects have a privileged position in politics.

The research conducted for this paper also strengthened the case for pursuing the third paper (presented in Chapter 4). Identifying stakeholders in the public procurement process led me to texts on stakeholders and stakeholder management in project management literature. I found that the public is often considered an 'external stakeholder' in public procurement because of their status as users (of the public good or service) and as taxpayers and that public opinion is considered important from the project management perspective (Morris, 1985). More recent work in public management also mentions the importance of managing public opinion for project success (Locatelli et al., 2017; Ninan et al., 2019). Brunet and Aubry (2016) describe how major public projects are increasingly responding to a broader definition of accountability, like public accountability, rather than "accountability from a strictly managerial perspective" (p. 1603). The third paper draws on this literature to propose a study of public opinion towards procurement projects.





# Chapter 4

## Public opinion on public projects

When reviewing the literature to understand what is different about defence, a prominent line of thought was regarding the differences in the political environment and the politics of procurement. Existing research argued that the public perceives defence differently, and defence projects enjoy greater public legitimacy (see Chapter 1, section 1.1). The systematic literature review of the public procurement and innovation literature (Chapter 2) also suggested that defence is different because of the political environment within which it operates. I was, therefore, interested in studying public opinion. Including the study of public opinion and public perception responds to the third dimension in the research framework (Figure 1.4), i.e., perceptions about the question ‘is defence different?’.

The research presented in this chapter is also an extension of Chapter 3 – looking at the world of practice and stakeholders in the public procurement process suggested the inclusion of the wider public as a stakeholder. Including concerns of the wider public contributes towards reaffirming the place of democratic politics in public projects and supports the arguments made by Willems and Van Dooren (2016) about ‘(re)politicizing’ policy on and management of public projects.

This chapter contains the third paper of the thesis. The first part of this chapter includes the journal-style research article. An abridged version of the article was submitted to *Public Management Review* in March 2021 and received a ‘revise and resubmit’ decision. After the paper (at the end of the chapter), I describe the specific contributions of this research towards the thesis.

### Abstract

Large public projects (or megaprojects) typically have lengthy timelines for development, production, and delivery. Public opinion towards such projects

may change over time. This paper investigates the factors behind changes in public opinion. The empirical context is four public projects in the UK, each spanning a development and delivery period of at least 15 years. The research method involves the use of newspaper articles as a proxy for public opinion. A lexicon-based sentiment analysis technique is used to determine sentiment scores of articles published over time. The analysis shows that public opinion goes through peaks and troughs and that factors which explain periods of positive or rising public opinion are few in number and are common across projects, while factors behind periods of negative or falling public opinion are more numerous and sometimes unique to projects. These observations contribute to the conversation on public management of megaprojects as (1) it demonstrates that public opinion can be a barometer for project performance and that (2) megaprojects operate under the Anna Karenina principle – success not only requires the presence of certain factors but the absence of a diverse range of factors which lead to failure.

**Keywords** Megaprojects, public opinion, sentiment analysis, Anna Karenina, fragility

## 4.1 Introduction

Large public projects, sometimes referred to as megaprojects, major projects, or major government programmes, attract the attention of a wider public beyond those directly involved in their development. Public interest is not difficult to explain – megaprojects are complex and risky ventures undertaken collectively at the societal level and are typically resource-intensive. Such projects can have an impact millions of people and lead to many desirable outcomes: job creation, improvement of economic productivity, and other benefits for the society that may continue for several generations; but if they go wrong, they turn into juggernauts that can damage societies, perpetuate inefficiencies, and waste precious public resources (Walker, 2000). Megaprojects are becoming an increasingly common means of delivering public services in many countries (Flyvbjerg, 2014), and there is a growing interest in understanding the relationship between public opinion and megaprojects (Eskerod and Ang, 2017; Ninan et al., 2019; Esposito et al., 2020).

The study of project narratives and understanding the relationship between projects and public opinion requires viewing projects across time, following projects as they develop and evolve. However, within the project management literature, most researchers take a snapshot view of projects rather than a long-term view. A snapshot view has two drawbacks. Firstly, such a view naturally focusses on project delivery with much less focus on stakeholders and people involved in the project and how they are affected by the changes brought about by the project (Dalcher, 2012). Secondly, a snapshot view misses the dynamism of projects and how stakeholder engagement changes over different project stages (Aaltonen and Kujala, 2010; Di Maddaloni and

Davis, 2018). In order to gain a comprehensive view of megaprojects and understand the relationship between public opinion and megaprojects, it is important to engage in long-term temporal analysis. A temporal analysis of public opinion towards projects may help us respond to the conundrum of some projects getting cancelled because of public debate and some projects being realised despite public opposition (Morris, 1985).

Moreover, stakeholder management for projects often emphasises the local community (like Rydin et al., 2015; van den Ende and van Marrewijk, 2019), but large public projects have wider impacts beyond local and regional economies. Studying the concerns of a more diverse public (i.e., beyond the local community) may raise issues beyond the siting of a project. Afterall, “the public” is not a micro-level agent but a macro-level abstraction, and public opinion is a contested field where different narratives may dominate from time to time. Thus, it is important to study public management for megaprojects differently.

This paper focusses on public opinion towards megaprojects and seeks to understand why public opinion changes over a project’s lifetime. It proposes a framework for the systematic study of public opinion by using text-based sentiment analysis techniques. The empirical work involves investigating four major public projects in the UK, each with a project history of fifteen years at least. A comparative perspective allows exploration of whether common factors to explain success and failure in major projects across industries and sectors. Research on major projects places much emphasis on the identification of critical factors and best practices to manage performance. Flyvbjerg (2014) focusses on the need to manage optimism bias, and Holweg and Maylor (2018) suggest a ‘predict-and-prevent’ approach in project management. There is a larger discussion here about the generalisability or context-specificity of factors which affect projects (Engwall, 2003; Dalcher, 2012). Our empirical work makes it possible for us to explore whether the issues which affect public opinion towards megaprojects are common or unique across projects. A better understanding of when and why the public is happy or unhappy about projects will be useful for project leaders, policymakers, public representatives, and public servants who can make decisions and interventions on public projects in various capacities.

Our empirical setting includes two military projects and two (civil) infrastructure projects, and we also take the opportunity to explore whether there are any structural differences in public opinion towards military and non-military projects. Indeed, as it is often claimed that the public has a limited understanding of military policy (Hartley and Russett, 1992; Eckles and Schaffner, 2011), which allows the military establishment to operate with secrecy (Alic, 2007) and enjoy greater public legitimacy (Nelson and Langlois, 1983), we explore civil-military differences as a secondary research interest in this paper.

The next section provides an overview of the relevant literatures on public opinion and project management. The methodology section describes the method-

ological framework used in this study, including the empirical context and the data collection strategy. The findings section provides the results of sentiment analysis for each of the four projects. The discussion compares the projects and is followed by a conclusion.

## 4.2 Literature Review

Megaprojects, by their very nature, generate opinions – favourable or otherwise. These projects are large-scale and have wide impacts (some examples are energy-generating facilities, buildings, bridges, transport and communication networks, and weapons systems). They can create and sustain jobs, increase an economy’s productivity, and improve social well-being. They can also displace communities, waste public money, and damage the ecosystem (Walker, 2000). Therefore, the general public has a diversity of opinions on public projects based on their purpose and performance and their own relationship with the project.

Although it is easy to identify a local community as the ‘public’ associated with a public project (based on its location), megaprojects have much wider impacts on people beyond this narrowly defined public. The wider public is referred to as ‘external stakeholders’ or secondary stakeholders in large public projects. Opinion of the wider public can influence decision-making in megaprojects. Flyvbjerg (2014) explains how the ‘promoters’ of megaprojects try to manipulate public opinion by infusing the narrative with optimism – understating costs and overstating benefits. Sometimes, a symbolic dimension is introduced to the project’s purpose to make a more compelling narrative (Sangvai, 1994; Rego et al., 2017). The role of policy narratives in megaprojects is the focus of Esposito et al. (2020). There is, therefore, also an attempt to control and manage public opinion towards large public projects.

Public engagement and public participation can take the form of public support for, or collective action against, major projects (Rydin et al., 2015; Liu et al., 2018). Lack of public support or negative public opinion can lead to additional costs and delays in a project through protests, demonstrations, and other activities that hinder progress on a project. For example, Novy and Peters (2012) use the case of Stuttgart 21, a railway station megaproject, to explore power, politics, and public participation and highlight controversies in megaproject development. Ninan et al. (2019) discuss the use of social media by a metro rail organisation in India to manage external stakeholder expectations towards infrastructure projects and reduce the probability of protests. Esposito et al. (2020) look at an EU-level project (the Lyon-Turin railway line) and also find that protests and opposition have negative consequences for project teams (impact on costs, schedules, and reputational damage).

Megaprojects are dynamic and public opinion evolves over time. Aaltonen and Kujala (2010) provide a conceptual framework arguing that stakeholder engagement does not maintain a steady-state across the project lifecycle and is

affected by project characteristics like its irreversibility after a point. Di Madaloni and Davis (2018) interview project managers and describe shifts in local community attitudes to major public infrastructure and construction projects, ranging from initial shock and opposition to eventual acceptance and understanding. Researchers have also used data from social media to understand public opinion towards a specific project and have noted changes in public opinion over time. For example, Jiang et al. (2016) present evidence of sentiment changing over a two-year period in their study of the Three Gorges project in China. Zhang et al. (2018) develop a ‘social sensing’ system, using data from individuals reacting to the project on social media platforms (i.e., individuals as ‘sensors’) to map public opinion on a major project and observe changes in sentiment over time.

## **Symbolism, optimism, and public opinion**

Since public opinion towards projects can evolve over time, it is possible to conceive public opinion as a contested field for promoters and opponents of megaprojects with each group seeking to control the project narrative. In the case of megaprojects, promoters may try to infuse the project narrative with symbolism and optimism. Sangvai (1994) comments on the role of nationalism in discrediting opposition to megaprojects in India and the association of a nationalist narrative and symbolism with megaprojects has been found by researchers in different empirical settings, like Brazil (Rego et al., 2017), Australia (Steen et al., 2017), and Italy and Tajikistan (Menga, 2018).

There is a persistent argument, usually based on Hirschman (1967), that optimism, a certain level of ignorance about risks, and an emphasis on symbolism or iconography is essential for megaprojects to come into existence and deliver their potentially transformational benefits to society. At the same time, some in project management research are critical of the role of optimism in megaprojects, arguing (like Flyvbjerg, 2014) that although project planners can use optimistic cost-benefit analyses to get projects started, real challenges soon emerge, which then demands more resources and ultimately delivers the project (if at all) by overshooting initial cost estimates and time schedules.

Plotting public opinion towards megaprojects can reveal the contest between exuberant optimism and a cautious or critical approach since changes in the trajectory will indicate changes in collective public opinion. Existing research has not sufficiently exploited new research methods to conduct such an exercise. In this paper, we propose the use of sentiment analysis, an automated text analysis technique which extracts emotions or sentiments from written documents, to plot the trajectory of public opinion over the typically long development and delivery period of megaprojects. A sentiment plot could give us insights into the tendency of public opinion to be optimistic or cautious about projects, and the analysis of project narratives could provide information on the use of symbolism.

## Issues affecting public opinion

Plotting the progression of public opinion over time can also help in identifying critical time periods and issues which affect public opinion. Understanding the issues associated with changes in public opinion could further our knowledge of critical factors that contribute to the success or failure of projects. Such an understanding is particularly relevant for megaprojects which are inherently complex and notorious for exceeding time and budget expectations. Project management research is acutely concerned with the identification of critical factors which affect project performance (Bryson and Bromiley, 1993; Pinto and Kharbanda, 1996; Chang, 2013; Lichtenberg, 2016; Söderlund et al., 2017; Holweg and Maylor, 2018).

Researchers have warned about the context-specificity of critical factors associated with projects (Engwall, 2003; Dalcher, 2012) and there are doubts about whether critical challenges for a project can be predicted at all (Flyvbjerg et al., 2020). Megaprojects exemplify the kind of rare and improbable events termed ‘Black Swans’ (Taleb, 2007), suggesting that it may be impossible to anticipate risks and challenges to the project. We think that doing a comparative analysis of factors behind success and failure for a few projects can be helpful in finding out whether critical failure factors are common across projects or unique to projects. Therefore, we are also interested in comparing the issues associated with positive and negative public opinion towards projects to identify whether there are any common critical factors across projects.

### 4.3 Methodology

Many of the challenges in studying public opinion over time are methodological. Public opinion is an abstract concept and has long been of interest to researchers in political science, sociology, social psychology and other disciplines. Some of the earliest works on attitude and opinion research can be found in the 1920s (Lasswell, 1931; Stephan, 1957). An interest in political movements and political changes became linked with an interest in public opinion since political movements follow a course “from outraged *sentiments* to decisive action” (Lasswell, 1931, p. 312, emphasis added).

Statistical techniques helped measure and compare public opinion across space and time, creating exciting possibilities for research (Thurstone, 1928; Rice, 1930). Surveys were the dominant method in public opinion research. Surveys could be in-person, over the telephone, mailed, or (as the internet became common) conducted online, usually with a questionnaire. The responses would then be aggregated and analysed as ‘public opinion’. However, surveys are expensive and resource-intensive exercises, which itself poses significant challenges to the task of gathering public opinion on highly specific topics. In the special case of obtaining public opinion over a long period towards a public project, surveys need to be conducted repeatedly across time.

In such a situation, archival research is usually pursued and a number of researchers have looked at media sentiment to understand prevailing public opinion (Verhoeven and Duyvendak, 2016; Metze, 2017). Mutz and Soss (1997) describe how “mass media coverage of an issue can serve as a surrogate for more direct expressions or solicitations of public opinion” (p. 432). Fan (1988) even suggests the ability to predict public opinion based on news content since the press plays an active role in shaping public opinion. At the same time, there has been evidence of a more reactive role of the media, i.e., rather than leading public opinion, it is itself influenced by the public mood (Habel, 2012). The close links between news media and public opinion are often exploited in existing research and media sentiment is considered a proxy for wider public opinion.

However, media sentiment may not perfectly represent public opinion for a number of reasons. Firstly, media outlets may have their own preferences regarding megaprojects. As a result, they may amplify some concerns or neglect some perspectives. Our study has attempted to control for this by taking every major newspaper – national and local, broadsheet and tabloid, liberal and conservative, subscription-based and freely available – into consideration. Secondly, framing theory suggests that news reports can place a topic within a field of meaning and this presentation can influence the public interpretation of news (Tewksbury and Scheufele, 2008; Vreese and Lecheler, 2016). Interpreting media sentiment as public opinion risks inadvertently and implicitly including the frames used by journalists in research.

Despite these limitations, existing researchers have used mass media as a source of information about public projects. Olander and Landin (2005) describe the media as having a ‘unique position’ in the project process as “they cannot really be defined as a stakeholder because they have no actual stake in the project” (p. 327) but nevertheless provide useful insights from a cross-section of project stakeholders. Media outlets are an important source of information on the opinions of various stakeholders, including government officials who may have oppositional views that are easier expressed to journalists (Verhoeven and Duyvendak, 2017).

We follow a tradition of scholarship that considers sentiments expressed in media to be a valid measure of public opinion. We use articles published in national and local newspapers about procurement projects and are essentially capturing media sentiment, but given the literature tradition, the close links between the media and the wider public in a democracy, and our data collection strategy (explained later), which covers a large number and variety publications, we consider media sentiment as synonymous to public opinion.

## **Empirical context**

This paper investigates public opinion towards four major projects in the UK from recent years. The UK provides an appropriate empirical context for

this research as there exist both large public projects pursued by the British government and multiple newspapers (national and regional) that report (independently of the government) on the progress and utility of these projects. Thus, setting this research in the UK provides rich sources of data from newspaper archives.

Four projects were selected from the *Government Major Projects Portfolio 2019*: the Queen Elizabeth programme (development of two aircraft carriers for the Royal Navy), Armoured Cavalry 2025 (procurement of armoured fighting vehicles for the British Army), the Thameslink Programme (purchase of trains for a commuter service running across London), and the Intercity Express Programme (improvement of railway services between major cities in the UK on the East Coast line and the Great Western route). All four programmes have a sufficiently long project history and have made tangible progress over time. They also share some similarities — each project has an element of public procurement that is easily identifiable and belong to the manufacturing sector (shipbuilding, armoured vehicles, railway rolling stock).

## Data collection

In order to search for newspaper articles on each project, the Lexis Library News database was used. The website allows a search to be conducted across 18 national newspapers<sup>1</sup> and 53 regional newspapers<sup>2</sup> in the UK. Newspaper articles for each project were found by searching for specific terms (Table 4.1). The search was conducted for entire calendar years (January to December). The choice of years depended on the official dates when the projects began<sup>3</sup>.

Newspaper articles were manually selected for relevance and to avoid dupli-

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<sup>1</sup>Daily Record and Sunday Mail, Daily Star, The Daily Mail and Mail on Sunday, The Daily Telegraph, The European, The Express, The Guardian, The Independent, MailOnline, The Mirror (The Daily Mirror and The Sunday Mirror), The News of the World, The Observer, The People, The Sun, The Sunday Express, The Sunday Telegraph, The Sunday Times, The Times.

<sup>2</sup>Aberdeen Evening Express, Aberdeen Press and Journal, Bath Chronicle, Belfast News Letter, Birmingham Evening Mail, Birmingham Post, Bristol Post, Coventry Evening Telegraph, Coventry Newspapers, Daily Post (North Wales), Derby Telegraph, East Anglian Daily Times, Eastern Daily Press, Evening Chronicle (Newcastle), Evening Gazette, Evening News (Norwich), Evening Star, Evening Times (Glasgow), Exeter Express and Echo, Gloucestershire Echo, Grimsby Telegraph, Hull Daily Mail, Johnston Press plc, Leeds Weekly News, Leicester Mercury, Liverpool Echo, Manchester Evening News, Northcliffe Newspapers, Nottingham Post, Regional Independent Media, Scotsman, Scunthorpe Telegraph, South Wales Echo, South Wales Evening Post, Sports Argus, Stoke the Sentinel, Sunday Mercury, Sunderland Echo, The Citizen Gloucester, The Evening Standard (London), The Herald (Glasgow), The Northern Echo (Newsquest Regional Press), The Plymouth Herald, The Sunday Herald (Glasgow), The Western Mail, Torquay Herald Express, UK NewsQuest Regional Press, Wales on Sunday, Western Daily Press, Western Morning News, Yorkshire Post.

<sup>3</sup>A reason for choosing newspapers as the source of archival data, rather than social media like Facebook or Twitter, is that social media archives do not stretch back as far in time for the projects being studied here.



Table 4.1: Data collection

Project name	Queen Elizabeth programme	Armoured Cavalry 2025	Thameslink	Intercity Express Programme
Search terms <sup>†</sup>	“new aircraft carrier” OR “new aircraft carriers” OR “future aircraft carrier” OR “future aircraft carriers” OR “aircraft carrier alliance” OR “HMS Queen Elizabeth” OR “HMS Prince of Wales” OR “Queen Elizabeth class”	“armoured reconnaissance” OR “armoured fighting vehicles” OR “family of light armoured vehicles” OR “FRES” OR “scout specialist vehicle” OR (ajax w/p armoured) OR (ajax w/p army)	“Thameslink 2000” OR (thameslink w/p train*) OR (thameslink w/p “rolling stock”) OR (thameslink w/p programme) OR “thameslink modernisation” OR (thameslink w/p upgrad*) OR (thameslink w/p contract) OR (thameslink w/p plan*) OR (thameslink w/p “project”) OR (thameslink w/p Siemens) OR (thameslink w/p Bombardier) OR (thameslink w/p franchise)	(“intercity express” w/p programme) or (“inter city express” w/p programme) or “intercity 125” or “inter city 125” or “inter city 125s” or “inter city 125s” or “inter city train” or “inter city trains” or “inter city train” or “inter city trains” or “IEP” or “intercity express programme”
Time period	1998 – 2019	1989 – 2019	2005 – 2019	2005 – 2019
National newspaper (hits)	4963	4093	4173	1270
National newspaper (selected)	1765	391	620	198
Regional newspaper (hits)	3627	2337	3307	2472
Regional newspaper (selected)	1212	203	664	657
<b>Total (selected)</b>	<b>2977</b>	<b>594</b>	<b>1284</b>	<b>855</b>

<sup>†</sup>w/p implies search terms should co-occur within the same paragraph; w/s implies search terms should co-occur in the same sentence; asterisk character is used to substitute any number of characters after the word.

cation. For an article to be relevant, it had to prominently and substantially discuss the project (ideally within the first 100 words of the article). Although the search terms were tested with a small set of articles, there were instances where the terms captured irrelevant articles (for example, China’s “new aircraft carrier” or “intercity trains” in Germany). However, refining the search terms any further led to losing potentially useful articles, and therefore the automated search was followed by a manual selection. It is also worth noting that ‘articles’ do not only mean newspaper reports on events but also commentaries, editorial and op-ed pieces, and letters to editors. Van Dalen (2012) notes that the UK has a journalistic culture that values conflict and gives space to both kinds of opinions in case of controversy. This makes the data rather cacophonous, which is probably an advantage as public opinion is better reflected as an amalgamation of many voices.

A final note on data collection is necessary to clarify why data from opinion polls (e.g., British Social Attitudes Survey, Gallup World Poll) were not used as an alternative or a supplement to newspaper data. Public policy researchers are often able to exploit such survey data, but the context of this paper is projects and not policy or institutions. Opinion polls also do not allow the level of granularity in time-series that newspapers can – polls are conducted annually or every few years; newspapers are printed every day.

## Data analysis

In order to understand the underlying opinions and sentiments from written texts, it is important to devise systematic coding strategies. DeWeese (1976, 1977) provides some very early reflections on the use of computerised techniques to analyse newspaper content. Computer-based text analysis techniques like sentiment analysis refer to the “systematic computer-based analysis of written text or speech excerpts for extracting the attitude of the author or speaker about specific topics” (Stieglitz and Dang-Xuan, 2013, p. 226). Computer-based sentiment analysis introduces speed and consistency to text analysis (Jiang et al., 2016; Mahadzir et al., 2016; Uren et al., 2016).

In this paper, we conducted sentiment analysis of newspaper articles by calculating a sentiment score for each article. In order to calculate the sentiment score, the *sentimentr* package developed by Rinker (2017) has been used. It is described as ‘an augmented dictionary lookup’ by its creator since it follows the dictionary principle for detecting sentiment in a text, i.e. words present in the text are tagged according to a pre-defined dictionary or lexicon<sup>4</sup>. Valence shifters in front of words are also taken into account (negations like ‘not’, amplifications like ‘really’, de-amplifications like ‘hardly’ and adversative conjunctions like ‘but’) which increases the accuracy of sentiment scores. The sentiment function produces a score that controls for variance in the length

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<sup>4</sup>Positive and negative words are given a +1 and -1 score respectively and tagged according to a combination of two dictionaries – Jockers (2017) and Hu and Liu (2004).

of articles by dividing the sum of sentence-level and paragraph-level scores by the total number of words.

### **Validity and reliability of sentiment scores**

The validity of sentiment scores as a measure of public opinion can be established by using sentiment dictionaries that have been compiled from large-scale crowdsourcing projects undertaken by researchers in natural language processing. For the purposes of this research, it was also important to establish the reliability of sentiment scores provided by the sentiment package against multiple human coders through inter-coder agreement. Would the relative ranking of articles, based on sentiment scores, change from one coder to the next?

An essential challenge in comparing sentiment scores with manual sentiment analysis is that human beings find it easier to rank things than provide objective and replicable scores. Therefore, the coding task was designed so that human coders ranked a subset of articles from high/positive opinion to low/negative opinion. The human rankings were then compared with the software's ranking (based on the scores). First, a subset of sixty articles was drawn for each project at random (without replacement). The sixty articles for each project were further grouped into sets of four at random. Human coders were then asked to compare four articles in a set at a time and rank them from 1 to 4, where 1 implies positive/high public opinion or public approval and 4 implies negative/low public opinion or public disapproval.

Three human coders were involved – two native English speakers<sup>5</sup> and the first author. The human coders worked independently of each other. The sentiment scores were converted into ranks, and the level of agreement was calculated by using Krippendorff's alpha (Krippendorff, 1970). According to Krippendorff (2004), alpha values over 0.67 can be accepted as reliable for drawing tentative conclusions. This is being met in most cases (Table 4.2).

There is often little difference between inter-human agreement and that between human ranking and sentiment scores, suggesting that machine-generated sentiment scores are fairly reliable. Because of the random draw, some sets consisted of articles where sentiment scores differed by very few points (0.01 or 0.005), which affected the machine's ranking but did not significantly affect the public opinion analysis ultimately (the analysis is based on scores, not ranks). At the same time, investigating cases of discrepancy between human rankings and sentiment scores revealed that opinion pieces are particularly susceptible to being given a relatively higher sentiment score (sarcasm and satire

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<sup>5</sup>Assisting coders were between the ages of 24 and 25 with postgraduate educational qualifications. By gender, one of the coders was male and the other was female. The former self-reported a high level of political engagement (voting, attending political campaigns and protests, member of a political party) while the latter reported a medium level of political engagement (voting, volunteering). Both reported consumption of news from a wide variety of sources (radio, television, newspapers, and social media) and having newspaper and magazine subscriptions.

Table 4.2: Inter-coder agreement on sentiment analysis

Project	Agreement between	Alpha	95% confidence interval
QEC aircraft carriers (n = 2977)	sentimentr and three human coders	0.756	(0.699, 0.8086)
	three human coders	0.756	(0.6707, 0.8320)
Armoured Cavalry 2025 (n = 594)	sentimentr and three human coders	0.738	(0.6868, 0.7886)
	three human coders	0.823	(0.7657, 0.8740)
Thameslink (n = 1286)	sentimentr and three human coders	0.626	(0.554, 0.6935)
	three human coders	0.730	(0.6353, 0.8121)
Intercity Express Project (n = 887)	sentimentr and three human coders	0.751	(0.6946, 0.8030)
	three human coders	0.832	(0.7812, 0.8806)

cannot be interpreted by the machine well). Human coders are better able to read between the lines and derive meaning and intention than the *sentimentr* package.

### Statistical techniques

Sentiment scores were aggregated on a monthly basis for meaningful analysis. This is in line with the existing work which considers the time variable for large projects (Jiang et al., 2016; Zhang et al., 2018). Monthly averages of sentiment help to smooth the sentiment plot without losing too much detail.

In order to detect changes in the trajectory of public opinion, the cumulative sum of monthly averages was used. Cumulative sum was calculated by first obtaining a normalised score ( $Z$ ) for each month.  $Z = \frac{x - \bar{x}}{\sigma}$ , where  $x$  is the sentiment score for that month,  $\bar{x}$  is the average of monthly sentiment scores, and  $\sigma$  is the standard deviation in the data. In the second step, the cumulative sum value was calculated by adding the  $Z$  value of a month with the previous sum of  $Z$  values.

## 4.4 Results

This section first describes the four projects with insights from sentiment analysis, which is then followed by a more global examination of results across the four projects.

### Queen Elizabeth programme

The Queen Elizabeth programme began in 1998 when the Strategic Defence and Security Review (SDSR) announced the intention to purchase two aircraft carriers. In 2017, the first of the two ships (HMS Queen Elizabeth) was commissioned, while the second ship (HMS Prince of Wales) was commissioned in December 2019. A total of 2977 articles were analysed for the Queen Elizabeth programme. The highest number of articles come from 2017 (Figure 4.1). There are also a large number of articles in 2010 – the Strategic Defence and Security Review (SDSR) of 2010 announced changes in the choice of aircraft

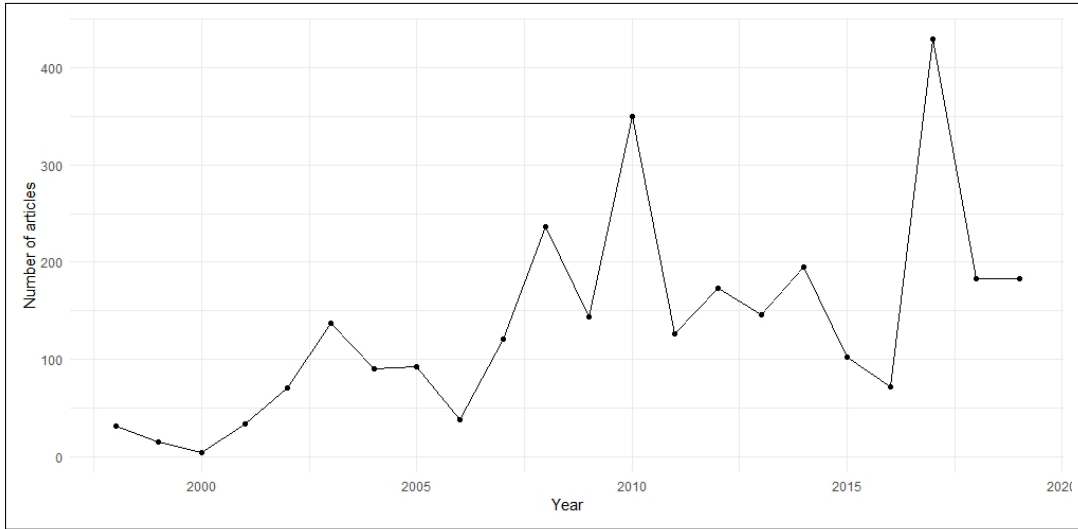


Figure 4.1: Number of articles on the Queen Elizabeth programme by year

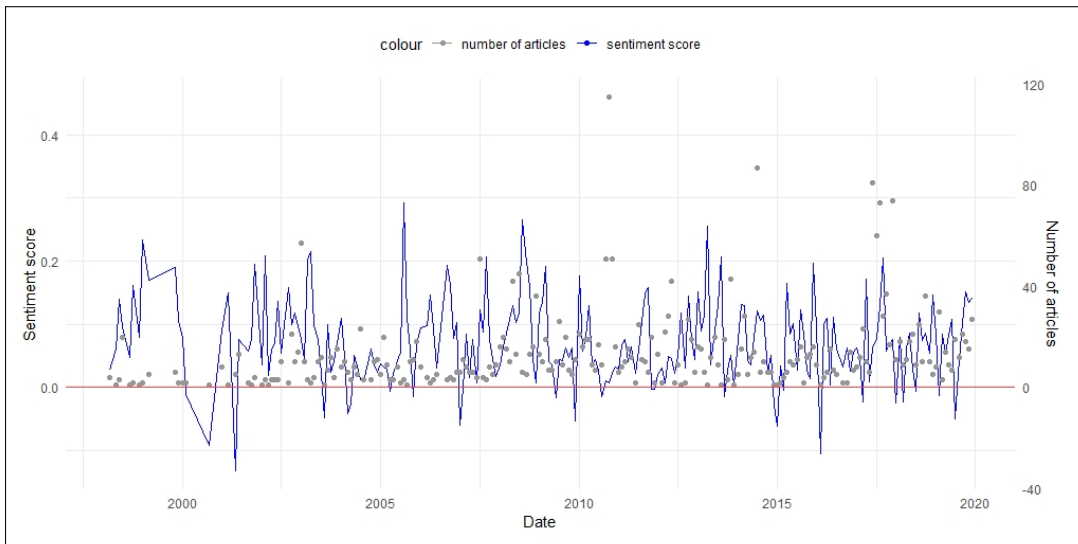


Figure 4.2: Average sentiment scores (by month) on the Queen Elizabeth programme

that would fly from the aircraft carrier. This decision was widely covered by newspapers and generated a large number of articles.

Figure 4.2 provides the sentiment scores along with the number of articles in each month. Sentiment scores (and by proxy, we assume public opinion) fluctuate over time with some months being characterised by high scores – indicating positive public opinion or public approval, and some months displaying low scores – indicating a negative opinion or public disapproval. Months with high average sentiment scores are usually ones where project milestones were achieved (July 2007 when the project is approved by the government, July 2008 when the manufacturing contract was signed, July 2014 when HMS Queen Elizabeth was launched, September 2017 when HMS Prince of Wales

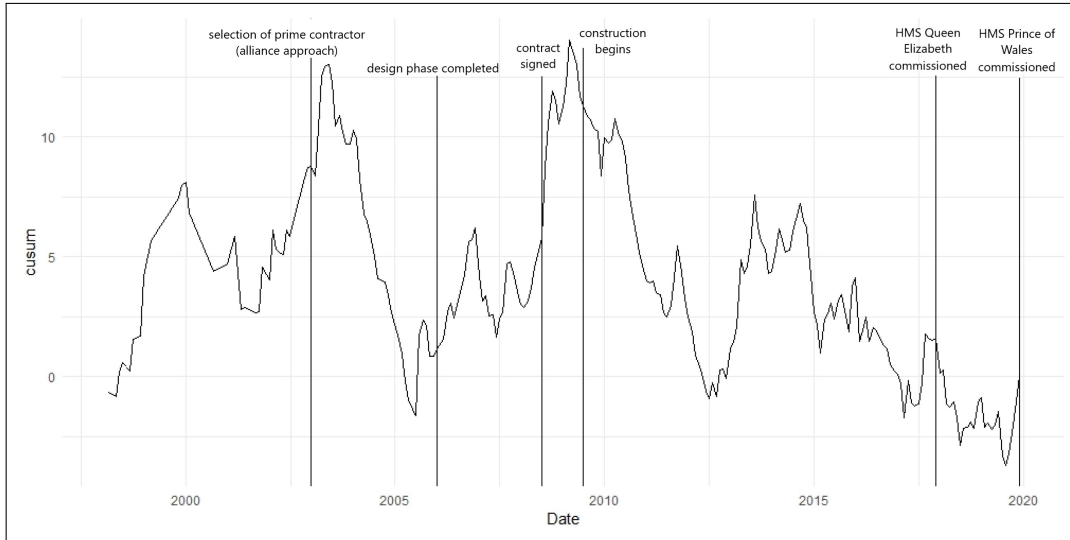


Figure 4.3: Sentiment scores (cumulative sum) over time (Queen Elizabeth programme)

was launched, etc.). Months where the average sentiment score is negative corresponded to periods when the project experienced problems. For example, in December 2009, the National Audit Office reported that delaying the carrier programme in 2008 had increased costs and contributed to a deficit in the defence budget.

Figure 4.3 plots the cumulative sum of sentiment scores and helps to trace the trajectory of public opinion over project history. The Queen Elizabeth programme began as a competitive tender with two contractors (BAE Systems and Thales) expressing interest. There were some misgivings about awarding the contract to BAE based on its performance in other defence projects at that time, but Thales was often referred to in the media by politicians and people as a ‘foreign’ company and any news of French involvement or collaboration on the carrier project was greeted with suspicion. The sentiment plot rises as more details emerge – in January 2003, the government announced an ‘alliance approach’ where both Thales and BAE would be involved in the carrier development. However, a brief rise in sentiment after the announcement was followed by a prolonged fall – the design and assessment phase was repeatedly extended, the design of the ships had to be changed to control costs, and there were conflicts about the roles and responsibilities of alliance members.

Sentiment rises around the time of contract signing and commencement of construction. However, from 2010 onwards, public opinion is on a downward trajectory again. News of cost increases, delays and fears of cancellations, changes to the choice of aircraft that would be used on the ships (from F-35B to F-35C and then back to F-35B) generate negative opinion. Progress in construction and news of sea trials and commissioning raise the sentiment score, but there have been technical issues with HMS Queen Elizabeth and

the F-35 since. Diplomatic issues with the deployment of ships have also led to a fall in sentiment scores in the last few years.

## Armoured Cavalry 2025

The procurement of armoured vehicles for the British Army has a long history. In the 1980s, a programme to replace the armoured fleet (reconnaissance vehicles, personnel carriers, and protected utility vehicles) was launched as FFLAV (Future Family of Light Armoured Vehicles). References to the FFLAV are found until 1992 after which the project started being referred to as TRACER (Tactical Reconnaissance Armoured Combat Equipment Requirement). A brief collaborative effort with the US on TRACER ended by 2000, and in 2003 the UK began to pursue its armoured requirement through FRES (Future Rapid Effects System)<sup>6</sup>.

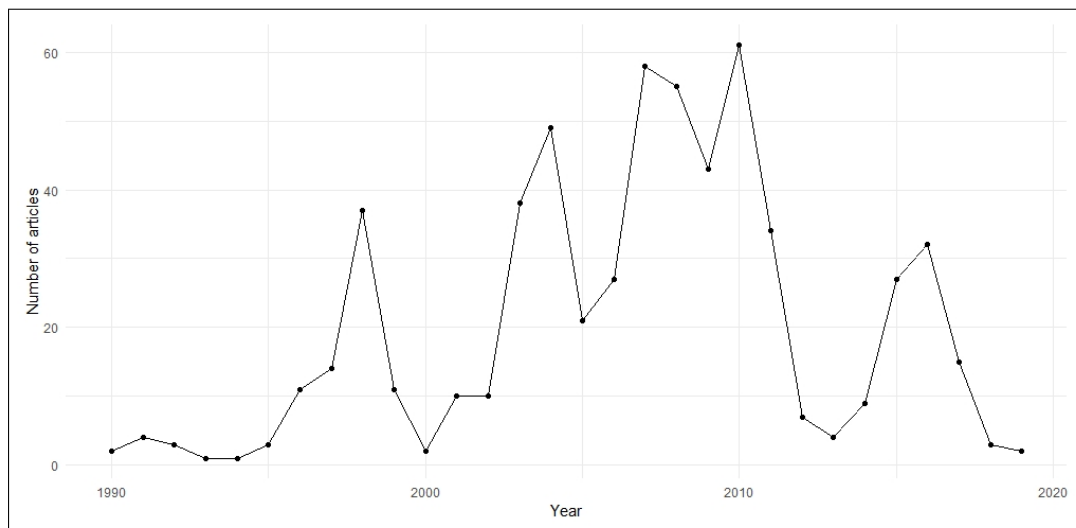


Figure 4.4: Number of articles on the Armoured Cavalry programme by year

The number of articles starts increasing from 2003 (Figure 4.4). The invasion and prolonged occupation of Iraq and Afghanistan brought attention to the state of Britain’s armoured fleet and the FRES programme. Delays to FRES were widely criticised in 2007 by the House of Commons Defence select committee. There was considerable public outrage in this period because of the lack of suitable armour for the UK’s ground forces in the war in Iraq. The highest number of articles is found in 2010, coinciding with the Chilcot inquiry on the Iraq war as well as the selection of General Dynamics (GD) for the armoured vehicles contract.

<sup>6</sup>There were more rounds of name changes: from 2008, FRES was reoriented as ‘Scout’ where the ‘Specialist Vehicle’ element was meant to address the replacement of reconnaissance vehicles. Armoured Cavalry 2025 officially started in 2014 and the Scout programme was subsumed under it. The family of armoured vehicles being developed now is called ‘Ajax’. In this paper, Ajax is sometimes used as a shorthand for the programme.

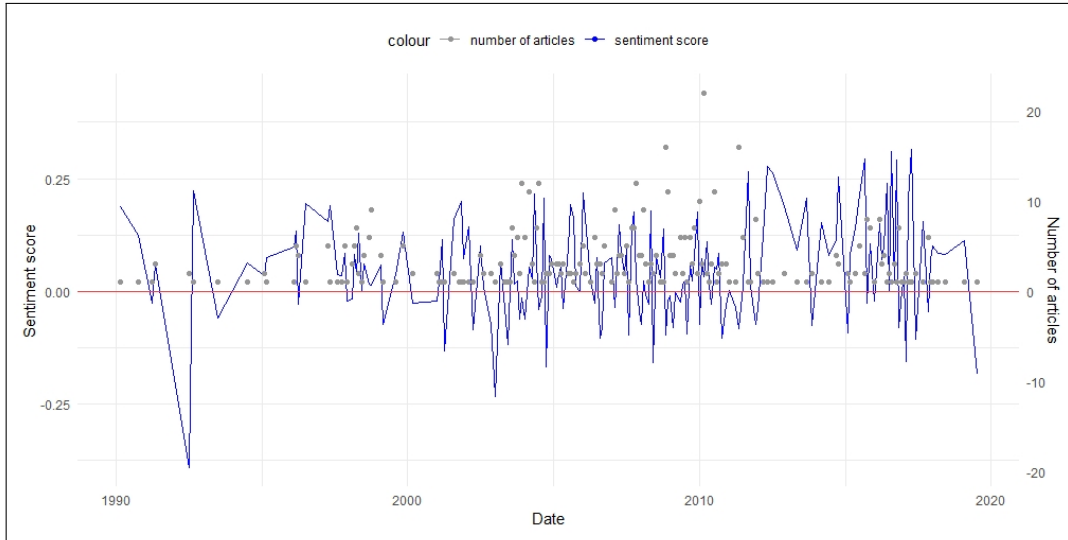


Figure 4.5: Average sentiment scores (by month) on the Armoured Cavalry programme

Figure 4.5 provides the plot for sentiment scores over time. The large fluctuation in the early years is partly due to the small number of articles. The project has more negative than positive news in the early noughties (for example, the pressure on the defence budget because of the Iraq occupation is frequently mentioned from 2004). Months with negative sentiment scores contain news of delays and lack of progress on the programme, especially in light of inadequately armoured vehicles for troops operating in zones of conflict between 2006 and 2011. Good months, when there are a number of articles with high sentiment scores, do occur in this period as well and make reference to the ongoing competition and awarding of design contracts for FRES. In later years (2014-2016), high scores correspond to months where announcements are made regarding production and subcontracts for Ajax.

Cumulative sum (Figure 4.6) shows that from 2003 public opinion falls as news of the Iraq war highlights pressures on the defence budget and the poor state of armoured vehicles being used. While there are brief periods when public opinion rises (choice of contractors on the FRES programme in 2004, awarding development contracts in 2005 and 2006, and updates on competition in 2007), there is little escape from the lack of tangible results from the programme while the occupation in Iraq and Afghanistan continues.

The invasion led the British Army to purchase armoured vehicles like the Mastiff and Jackal as ‘urgent operational requirements’ and upgrade ageing Land Rovers and Scimitar, and FRES was pursued for a ‘longer-term requirement’ (Comptroller and Auditor General, 2006, p. 161). However, the news of troops losing life and limb while inside inadequately protected vehicles during counter-insurgency operations and patrols meant that the delays and cost overruns on the FRES programme were severely criticised. Reports by the National Audit Office (November 2007, May 2011), Defence Select Commit-



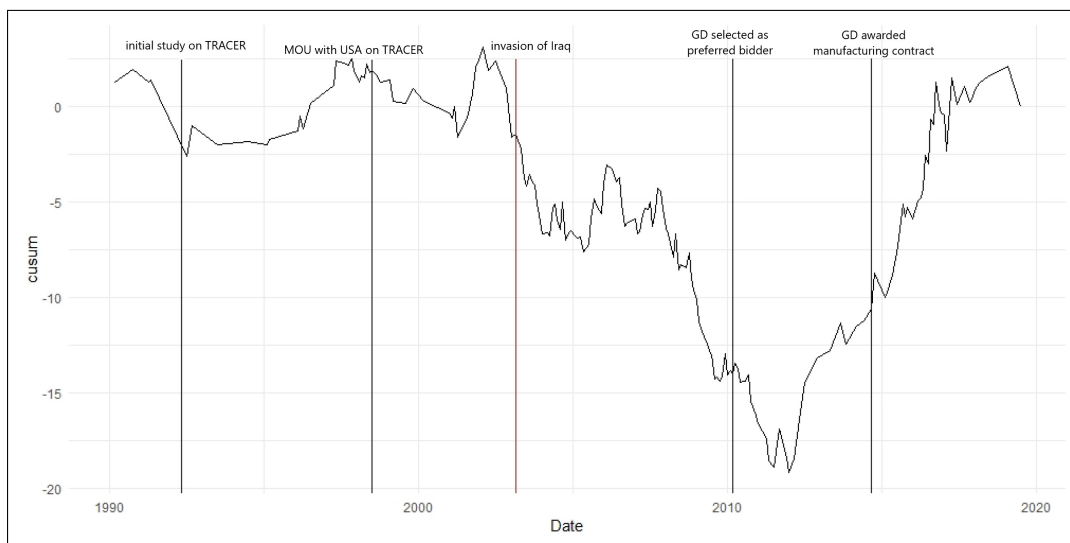


Figure 4.6: Sentiment scores (cumulative sum) over time (Armoured Cavalry)

tee (August 2006, February 2007, January 2008, February 2009), and Public Accounts Committee (February 2007, December 2011) generate highly critical newspaper commentaries on MoD's inefficiency and management of the programme.

It is only from 2012 that public opinion shifts towards an upward trajectory as the government confirmed that General Dynamics would be building the Scout vehicles in Wales. The unveiling of vehicles and manufacturing facilities, successful trials, and news of subcontracts lifts the sentiment scores. The small blip in this upward trajectory (from November 2016 to February 2017) is precipitated by a report in *The Times* claiming development problems with the turreted variant of the Ajax vehicles and a leaked document about the superiority of Russian tanks. Sentiment scores recover by mid-2017 as work continues on the Ajax and the first newly evolved strike brigade equipped with Ajax vehicles engages in military exercises.

## Thameslink programme

Thameslink was first opened in 1988 as a north-south London commuter service and became extremely popular. The first proposals for expansion and increasing capacity on Thameslink were made in 1989 but this was followed by a major restructuring of the railways (Railways Act in 1993 and 2005), affecting the possibility to plan and make progress. In October 2006, Network Rail (then a recently created arm's length public agency of the Department for Transport, responsible for Britain's rail infrastructure) was given planning permission to upgrade Thameslink. The aim of the programme was to increase capacity and reduce overcrowding on the line. It involved infrastructure development of stations and tracks, revised franchising of train operating services, and procurement of new trains. The invitation to tender for high-speed electric

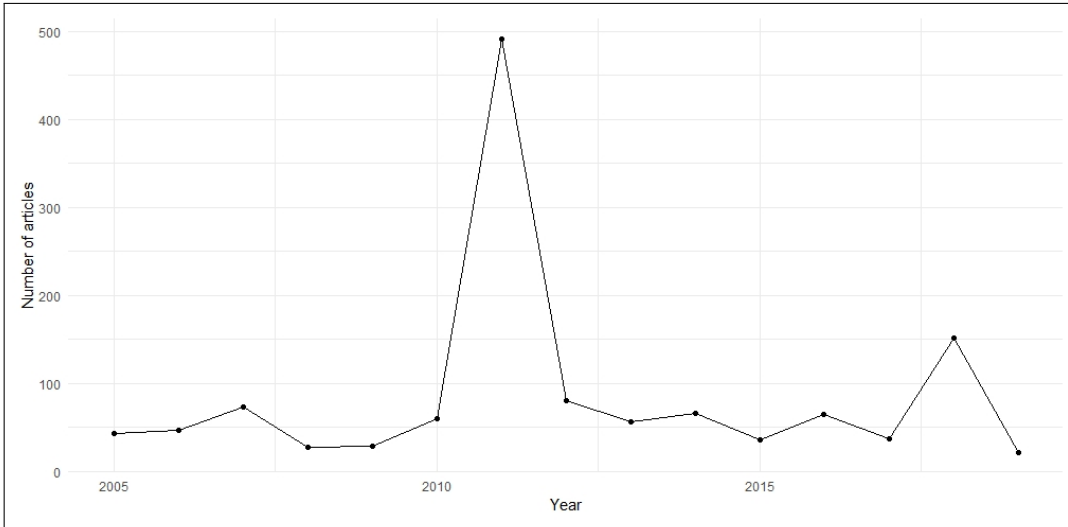


Figure 4.7: Number of articles on the Thameslink programme by year

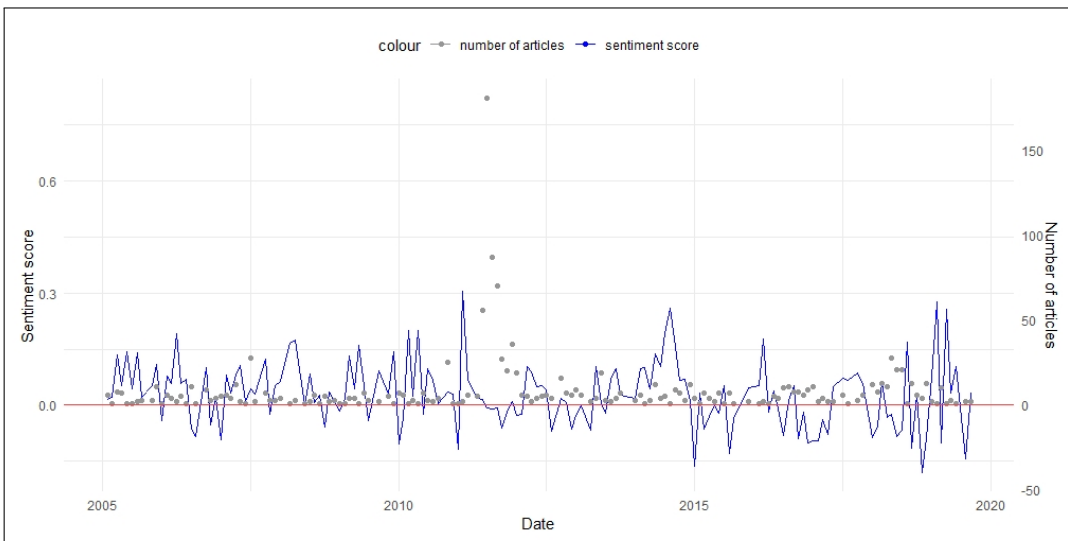


Figure 4.8: Average sentiment scores (by month) on the Thameslink programme

trains was issued in November 2008, and in June 2011 Siemens was announced as the preferred bidder.

The highest number of newspaper articles are from 2011 (Figure 4.7), when the Department for Transport (DfT) selected Siemens instead of Derby-based Bombardier for making the trains. The event was the focus of a large number of articles in the *Derby Telegraph* which led a campaign for changing the decision on the Thameslink contract. 2018 is another year when there are more than the usual number of articles. In May 2018, there was a large-scale revision of timetables to bring new trains into service, but this did not unfold as planned. The chaos caused was widely reported.

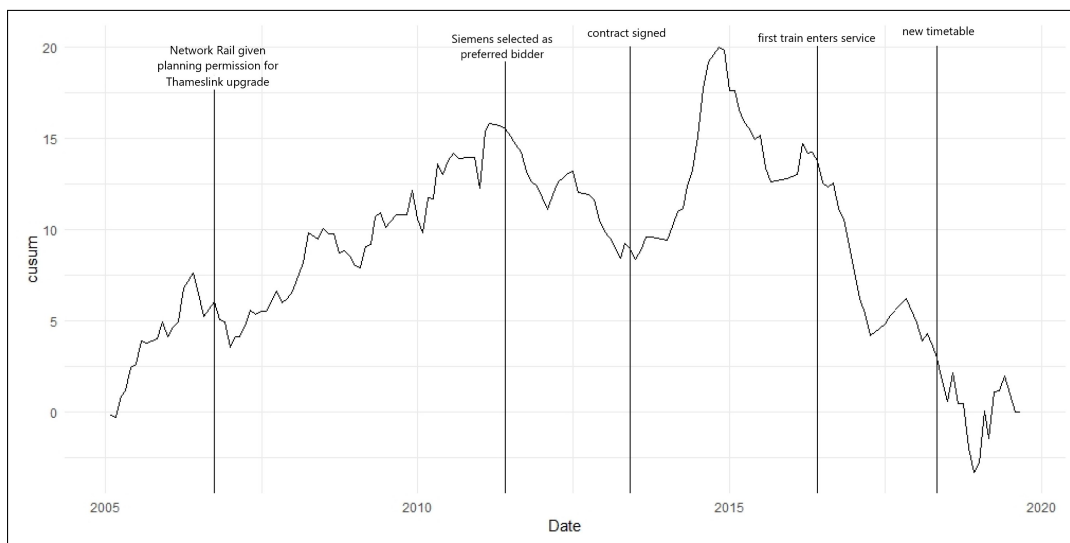


Figure 4.9: Sentiment scores (cumulative sum) over time (Thameslink programme)

Figure 4.8 shows the sentiment scores for each month. As with other projects, public opinion on Thameslink fluctuates over time. The exceptionally high number of articles in 2011 surrounding the selection of Siemens over Bombardier coincides with a substantial fall in sentiment scores.

Figure 4.9 provides the cusum plot. Public sentiment is on a generally upward trajectory after the project officially begins. However, public sentiment began to fall significantly following the announcement of Siemens as the winner of the rolling stock contract in June 2011. There was much anger over the selection of Siemens as it would be building trains in Germany, as opposed to Bombardier, which had a train-building factory in Derby. Bombardier announced imminent job losses, and *Derby Telegraph* (a regional paper), as well as the national press, presented the story as a blow to British manufacturing. The newspaper articles were particularly critical of the government's procurement strategy for not considering the socio-economic implications of the decision.

Contract signing was delayed because of the prevailing financial crisis in 2011 and 2012, and while public opinion made a recovery after the event and with news of the selection of train operating company in May 2014, by the end of 2014 sentiment scores, began a precipitous fall. This coincides with the station development work on London Bridge reaching a critical stage – disruption of services because of overrunning engineering works becomes a common story for the next three years. The introduction of new trains in 2016 does little to improve the sentiment as, by this time, it emerged that the train operating company (Govia) could not provide an adequate service due to engineering works and strikes. The DfT was blamed in the parliament (July 2016) and in select committees (October 2016) for the misery faced by commuters.

The new trains were not greeted enthusiastically by passengers – the seats

were compared to ironing boards and the train design privileged standing room over seats. In May 2018, with the completion of station work and delivery of new rolling stock, a major revision of train timetables to increase capacity took place. However, it appeared that the train operating company was not adequately prepared for the timetable changes. Public opinion continued to plummet in 2018.

## Intercity Express programme (IEP)

IEP was launched in 2005 as the Super Express Programme “to examine how the current Intercity 125 High-Speed Trains, introduced between 1976 and 1982 could be replaced” (Department for Transport, 2009, para. 57). After nearly thirty years of service, there was a need to change rolling stock, and the programme also provided an opportunity to purchase more environmentally efficient trains, so the DfT sought to buy electric trains to complement its wider electrification strategy.

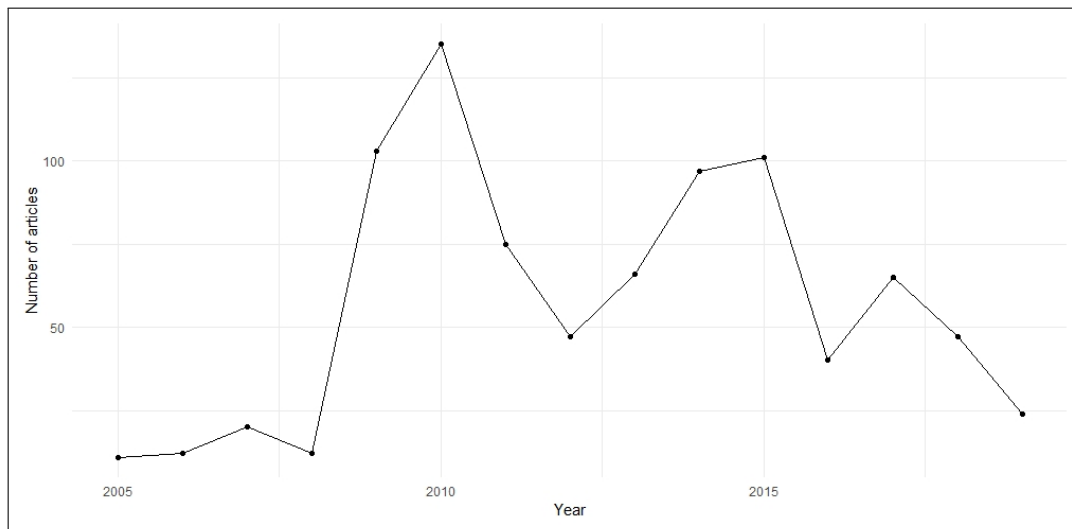


Figure 4.10: Number of articles on the Intercity Express Programme (IEP) by year

A large number of articles on the IEP were published in 2009 and 2010 (Figure 4.10). In 2009 the train manufacturer was chosen. The decision to award the contract to a Japanese firm (Hitachi) and overlooking Bombardier received a lot of press coverage. In 2010 the project faced a high degree of uncertainty as the government announced that procurement of new rolling stock might be shelved because of the pressures on public expenditure. 2015 also has many newspaper articles as the Hitachi factory was opened in northeast England (at Newton Aycliffe) in September of that year.

Figure 4.11 provides the sentiment plot and Figure 4.12 provides the cumulative sum of sentiment scores. The early articles mention overcrowding, poor services, and the need for new trains. Sentiment is on a prolonged downward

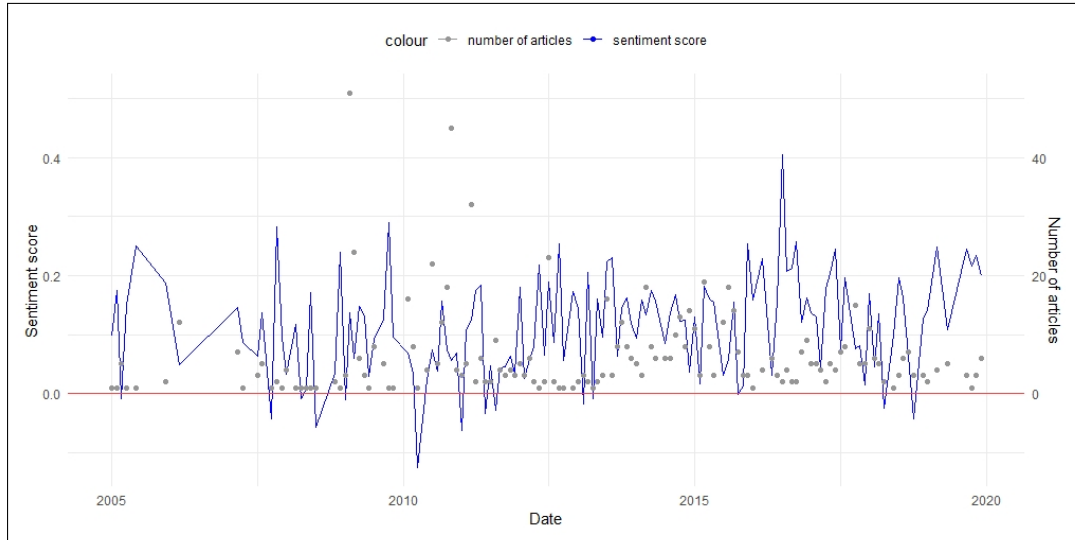


Figure 4.11: Average sentiment scores (by month) on IEP

trajectory until the contract is finally signed in July 2012 and work begins. The period before 2012 was quite difficult. In April 2008, the bidding period was extended, introducing delays in IEP. The fall was arrested somewhat by news in February 2009 about the selection of Agility Trains Limited (Hitachi and John Laing) as the preferred bidder.

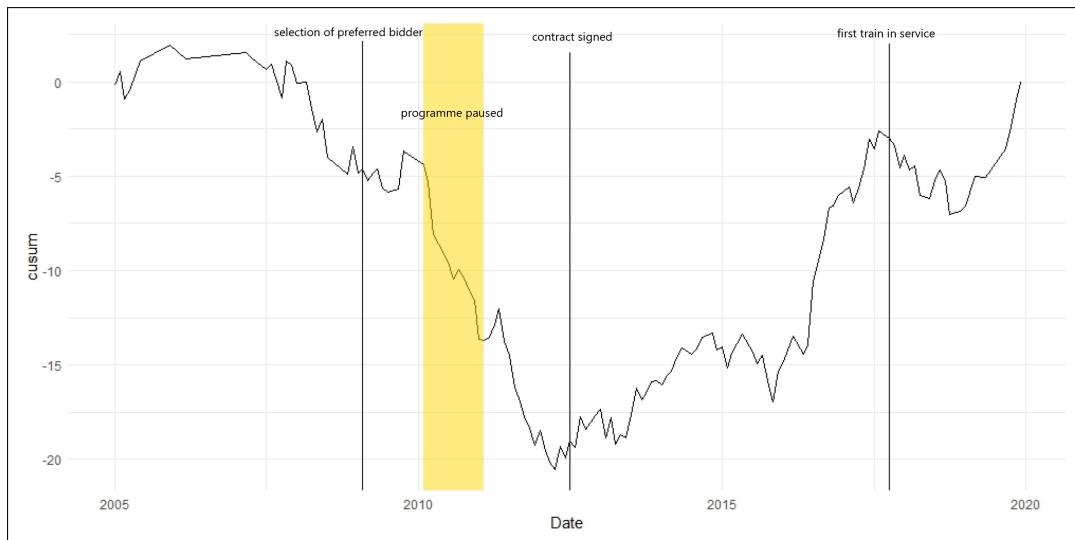


Figure 4.12: Sentiment scores (cumulative sum) over time (IEP)

In February 2010, the programme was paused for a review. This was greeted negatively by passengers who needed the service and regions hoping to benefit from Hitachi's investment in a train assembly facility. The period of uncertainty was put to rest only when the government confirmed IEP on 2 March 2011 with an announcement of a £5.2 billion investment programme. From June 2011, the cusum plot begins another downward journey with news of Bombardier being overlooked for the Thameslink contract. The public reac-

tion involved angry letters to the editor and commentaries on the “death of British manufacturing” and also referred to the 2009 selection of Agility Trains and Hitachi. In the first quarter of 2012, public opinion remained negative as it emerged that the contract for IEP had still not been signed.

However, the upward trajectory following the contract signing is not straightforward – there are several places where public opinion falls, corresponding to periods when instances of mismanagement by the DfT are revealed (management of franchises, electrification and infrastructure upgrade delays). Work on electrification of the Great Western Line was underway in October and November 2014. However, in 2015 it emerged that electrification would not be completed on time and taxpayers will have to pay Hitachi for the new “Super Express” trains that sit idle, pending the infrastructure work by Network Rail. This affected public opinion even after new trains started arriving.

## **Combined view of the results**

Sentiment analysis of newspaper articles allows us to plot the trajectory of public opinion over time. The first observation from the sentiment plots is that sentiment scores fluctuate substantially over time, going through peaks and troughs. In some cases, like IEP or Ajax armoured vehicles (Fig 4.6 and Fig 4.12), there seems to be a particularly significant trough, making the sentiment plot almost U or V-shaped. For the aircraft carrier and the Thameslink project (Fig 4.3 and 4.9), the sentiment plots do not exhibit the same behaviour and instead contain multiple peaks and troughs over the development and delivery period. It is perhaps interesting to note here that the sentiment plots do not show any structural differences between military and civilian projects.

The figures thus show that media sentiment or public opinion changes over time for all four projects. The project narrative is sometimes dominated by a positive tone (and the sentiment scores rise), and at other times by a negative tone (and the sentiment scores fall). None of the four projects experience a constant level of support or opposition over time. The newspaper articles come from diverse sources – national and regional, broadsheet and tabloid, left- and right-leaning. And yet when sentiment scores from newspaper articles are aggregated over time, the scores vary substantially from one period to the next, showing that public opinion is a contested field amongst opposing points of view.

## **Characteristics of news content**

The figures indicate periods of high and low sentiment for each project through the peaks and troughs in the sentiment plot, and we now focus on these periods and analyse the characteristics of news content to identify the issues that affect public opinion. In order to identify such periods, some selection rules were applied (see Appendix C.1) based on the number of articles and the average sentiment score (above the upper quartile or below the lower quartile). In

almost all cases, it was possible to identify the dominant stories of the months that had very high or very low sentiment scores.

Table 4.3 lists the factors with explanations on coding and exemplary headlines from projects (where they were found). The dominant stories were given one of the twelve codes listed in the table. The cells with ‘n/a’ denote that the factor was not found in the newspaper articles from the months under consideration for a particular project. The factors can be further categorised according to their frequency of occurrence across projects (Table 4.4). Sectors refer to ‘military’ and ‘transport’.

There are some factors that are common across projects and across sectors, suggesting some sort of universality in what constitutes good and bad news. For example, news of the manufacturing sector (opening a new factory, securing jobs in an industry, regional growth and revival) or the awarding of contracts and subcontracts can be found in months with high sentiment scores in most projects. Similarly, news of cost overruns and project delays and technical problems characterise the ‘bad months’. Outsourcing or awarding contracts to foreign firms are associated with low sentiment scores, irrespective of the manufacturing sector (armoured vehicles or railway rolling stock). The presence of technical problems in all four projects is unsurprising given the complex nature of all the projects and it is natural that such events will lower public sentiment.

On the other hand, factors occurring once or twice between the four projects are particularly informative because of their specificity. Some of these factors are sector-specific: inter-state strategic cooperation is typically found in the military domain, and equipment or staffing shortages compromising operational capability is a matter of national security. Pressures on the departmental budget are also found only regarding the military projects and do not feature as much for the transport projects, perhaps because funding arrangements are markedly different between the two (DfT pays the train manufacturer to make trains available to train operating companies who pay the DfT some of the revenue they generate from running train services)<sup>7</sup>. There is also a transport-specific factor – projected benefits of the programme feature in the months of high public opinion for transport projects only. This could be because people directly benefit from transport projects and only indirectly benefit from defence projects.

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<sup>7</sup>It would be very interesting to observe newspaper articles on transport spending in light of the coronavirus pandemic. In the UK, railways were briefly nationalized as the government assumed all the risks of providing a minimum level of public transport service even as passenger numbers fell dramatically. The share of financial risk assumed by government is much higher for national security than public transport otherwise (e.g. there are no fare-payers in defence).

Table 4.3: Dominant stories in months of high &amp; low public opinion

Type of period	Factor	Description	Queen Elizabeth programme (QEC)	Armoured Cavalry 2025 (Ajax)	Thameslink programme (TP)	Intercity Express Programme (IEP)
Months with high sentiment scores, or 'good' months	contract/subcontract award	signing of contracts or subcontracts related to the project	"MoD signals £3.9bn deal for super-carriers" (The Times, 21/05/08)	"Arms deal boost" (The Express, 22/10/14)	"Go-Ahead wins battle to run UK rail super-franchise" (The Times, 24/05/14)	"Glass maker seals major deal for North-East train building project" (The Northern Echo, 13/08/13)
	engineering/manufacturing sector	job creation, regional revival or economic growth, reports on construction activities	"Clyde yards are set for lift off" (Evening Times, 03/03/09)	"Merthyr at cutting edge of Army vehicle design" (The Western Mail, 07/03/16)	n/a	"Hundreds of businesses examine Hitachi opportunities" (The Northern Echo, 27/05/11)
	strategic cooperation	inter-state cooperation or collaboration	n/a	"Britain poised to join European arms agency" (The Times, 11/03/96)	n/a	n/a
	project milestone	successful completion of a project phase	"£3bn carrier sails to base for first time" (The Daily Mirror, 17/11/19)	n/a	"Planning go-ahead for Thameslink" (The Daily Telegraph, 19/10/06)	n/a
	projected programme benefits	anticipated benefits of programme	n/a	n/a	"Improvements promised on the trains" (Bedford Today, 10/05/05)	"Staying optimistic about town's future" (Gloucestershire Echo, 04/01/18)
Months with low sentiment scores, or 'bad' months	budget cuts	pressure on departmental budget	"Navy's new carriers delayed by cash cuts" (The Daily Mail, 12/12/08)	"Armed forces face two decades of cutbacks" (The Herald, 31/05/05)	n/a	n/a
	cancellation fears	project uncertainty and potential for cancellation	"PM stays silent on two carrier deal" (Evening Times, 04/10/10)	n/a	n/a	"New generation trains shunted into the sidings" (Gloucestershire Echo, 01/03/10)



Table 4.3 continued from previous page

Type of period	Factor	Description	Queen Elizabeth programme (QEC)	Armoured Cavalry 2025 (Ajax)	Thameslink programme (TP)	Intercity Express Programme (IEP)
	equipment/staffing shortages	lack of equipment or soldiers to conduct operations	“Royal Navy new aircraft carriers could be hampered by lack of personnel” (The Express, 15/03/17)	“Why our troops are fighting with equipment that isn’t up to the job” (The Sunday Herald, 10/09/06)	n/a	n/a
	loss to British manufacturing	awarding contract to foreign firms, job losses in domestic manufacturing	n/a	“Decline in MoD orders leads to loss of 25 jobs” (Leicester Mercury, 21/11/08)	“Experts predict impact of rail job losses on city’s economy” (Derby Telegraph, 17/10/11)	“We will all pay for Thameslink travesty” (The Daily Telegraph, 15/08/11)
	political challenges	diplomatic issues, unstable political environment	“Beijing scolds UK Defence Secretary over ‘gunboat diplomacy’” (The Express, 26/02/19)	n/a	n/a	“Brexit could damage Hitachi expansion at Newton Aycliffe” (The Northern Echo, 20/05/16)
	project management	delays, cost overruns, and other inefficiencies of procuring department	“Cost fears over new Royal Navy carriers” (The Herald, 13/10/03)	“MOD may delay new armour project” (Western Daily Press, 11/11/03)	“Network Rail asks for an extra £8bn” (The Times, 04/07/07)	“Taxpayers will pay price if intercity trains deal hits buffers” (Yorkshire Post, 17/12/14)
	technical problems	technical faults in new equipment affecting users and the system	“3 people nearly drown as 200 tonnes of water leak into carrier” (The Express, 10/07/19)	“Army’s new £3.5bn mini-tanks denounced as useless death traps” (The Times, 01/11/16)	“New train seats are so hard travellers told take a cushion!” (The Daily Mail, 19/02/18)	“Commuters complaining as doors fail to open on new trains” (The Western Mail, 14/02/18)

Table 4.4: Frequency scale for factors

Number of projects where factor is found	Comments on specificity	Factors from Table 4.3
4	Common to all projects	contract/ subcontract award, project management, technical problems
3	Fairly common	engineering/ manufacturing sector, loss to British manufacturing
2 (from different sectors)	Shared across sectors (military & transport)	project milestone, cancellation fears, political challenges
2 (from same sector)	Sector-specific (military/transport)	projected programme benefits, budget cuts, equipment/staffing shortages
1	Uncommon	strategic cooperation

### Factors behind changes in public opinion

Besides the issues which characterise the news content during periods of positive and negative sentiment, we are also interested in the factors that occur at turning points, where a sustained rise or fall in sentiment scores is reversed. Turning points can be identified with the help of cumulative sum. However, for a turning point to qualify for investigation, a rule on the number of articles until the next turning point was introduced. Thus, periods when opinion starts rising or falling would only be considered if there is a sustained rise or fall. Since the dataset for each project differs in size, the threshold for the number of articles between turning points differs as well. The details are provided in Appendix C.2.

Table 4.5 captures the factors found at the turning points of each of the four projects. Many of these factors are familiar from Table 4.3 except ‘disrupted rail services’ which has been introduced as a combination of stories making reference to poor quality of train service being experienced by passengers due to technical problems in the trains, chaotic timetables, strikes, and overrunning engineering works.

There are some interesting observations to be made. Firstly, there are more reasons for public opinion to start falling than to start rising. A rise in public opinion is confined to stories of awarding contracts and subcontracts, achievement of project milestones (approval, completion, inauguration), and positive news about the manufacturing sector. A fall in public opinion, on the other hand, is triggered by a variety of reasons. Some of these reasons are fairly common – news of delays and cost overruns or adverse effects on British manufacturing due to international competition and outsourcing, but there are more factors there are specific to certain sectors or projects. Even the composition of factors triggering a fall in public opinion differ from one project to the next.

A second observation from Table 4.5 is regarding the number of turning points

Table 4.5: Factors found during turning points

Reasons for ...	Factor	Description	QEC	Ajax	TP	IEP	Additional notes
Rise in public opinion	Number of turning points analysed		9	7	1	8	
	contract/subcontract award	signing of contracts or subcontracts related to the project	✓	✓	✓	✓	Common to all projects
	engineering/manufacturing sector	job creation, regional revival or economic growth, reports on construction activities		✓		✓	Shared across sectors
	project milestone	successful completion of a project phase	✓			✓	Shared across sectors
Fall in public opinion	Number of turning points analysed		11	11	5	6	
	budget cuts	pressure on departmental budget	✓	✓			Military-specific
	cancellation fears	project uncertainty and potential for cancellation				✓	Uncommon
	disrupted rail services	train cancellations due to engineering works, strikes, and technical problems with trains			✓	✓	Transport-specific
	equipment/staffing shortages	lack of equipment or soldiers to conduct operations	✓	✓			Military-specific
	loss to British manufacturing	awarding contract to foreign firms, job losses in domestic manufacturing		✓	✓	✓	Fairly common
	project management	delays, cost overruns, and other inefficiencies of procuring department	✓	✓		✓	Fairly common

analysed. When the criterion on the number of articles between turning points is introduced, we note more significant downward movements than upward turns for three of four projects. Public opinion appears more likely to fall than rise for major public projects, which supports the sentiment analysis findings of Zhang et al. (2018) and prompts us to view the role of public opinion within project management in new ways (which we discuss next).

## 4.5 Discussion

Megaprojects are characterised by lengthy development and delivery periods. Some people support or oppose a project from the beginning until the end, but it is also interesting to look at the public as a collection of disparate people. We find that public opinion understood thus and expressed through multiple newspapers, changes over time – none of the four projects under consideration experience constant public adoration or opprobrium. Public opinion responds to events, announcements, news of risks, challenges, and failures. Our findings, which are relevant for project management, are discussed in two parts. The

first, ‘public as a barometer’, discusses the characteristics of public opinion towards megaprojects and whether the public can be a barometer for project performance and contribute to project management. The second, ‘Anna Karenina Principle’, helps explain our ability (or lack thereof) to anticipate the issues which affect public opinion.

## The public as a barometer

We find that the public has justifiable reactions to projects. Sentiment scores are high when project milestones are achieved. News of jobs being created locally and potential for regional economic growth is greeted positively whereas awarding contracts to firms outside the UK is greeted negatively. Project management problems (delays, cost overruns, inefficient use of resource) are factors that characterise periods of low public opinion.

Existing research on megaprojects identifies technological risks (Bryson and Bromiley, 1993; Pinto and Kharbanda, 1996), the use of lowest price bidding (Chang, 2013), and wider political challenges (Söderlund et al., 2017) as factors which adversely affect project performance. We find these issues are noted in newspapers as well, and such articles express negative sentiment. Given the essentially political nature of megaprojects (Willems and Van Dooren, 2016), it may be beneficial to take public opinion into account and note the issues which affect people about a particular project to manage and govern megaprojects. For example, public opinion could be measured regularly during the long project development period.

The sceptical reader may argue that project managers are usually aware of risks, inefficiencies, delays, and cost overruns before the wider public (they may even be orchestrating events and press releases and sharing information selectively) and thus will derive little value from observing the rise and fall of public opinion over time. However, based on our findings, we argue that it is still important to stay in touch with public opinion because project managers and policymakers may not be able to anticipate the intensity of public emotion or reaction. For example, awarding the Thameslink contract overseas led to a very negative reaction among the British public. Newspapers often present stories in the backdrop of wider political and economic developments (see earlier reference to framing theory). In the case of megaprojects, negative media coverage may not only have implications for project managers, but also for the government and the private stakeholders involved<sup>8</sup>.

We find some examples of symbolism in our study, particularly for the QEC aircraft carriers, where public opinion is very high (and often peaks) when the ships are launched for sea trials or commissioned into service. There is

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<sup>8</sup>Continuing with the example of the Thameslink contract, it is possible to find premonitions of Brexit (“Contract decision shows why we have to leave EU”, *Derby Telegraph*, 30 June 2011), and anger towards private stakeholders involved (“£15m spent on train contract consultants”, *Derby Telegraph*, 3 August 2011; “Top Cameron aide derailed Bombardier”, *The Daily Mirror*, 6 August 2011).

a lot of public attention on the eve of such celebrations, and the challenges of the project (those already experienced and those yet to come) are rarely addressed during such times. However, more broadly, our analysis shows that public opinion is not entirely tied to symbolism and newspapers can provide critical scrutiny and counteract over-optimism.

For example, we find that public opinion is more likely to experience sustained downward turns than rises. Zhang et al. (2018), in their study, found that negative events cause “rapid and significant decrease of sentiment value” while positive events only lead to a slow and slight increase (p. 686). In our study, even key milestones rarely sustain a positive public opinion towards the project. For the QE carriers (Figure 4.3), the sentiment plot peaks when the first ship is commissioned (December 2017), only to swiftly fall as a leak is discovered on the ship, and the decision to commission the ship before completion of sea trials is criticised. For the Thameslink programme (Figure 4.9), the new trains were criticised for being uncomfortable, and the disruption experienced due to timetable changes and delayed services dominate the narrative (2018), even when the project reaches its conclusion.

The multiple peaks and troughs of sentiment scores may thus indicate that while optimism could play a role in getting megaprojects started (Flyvbjerg, 2014), public opinion is wary and unforgiving, quick to become critical when problems emerge. This can be seen for both military and non-military projects. It could be argued that this quick critical response is due to teething problems associated with the roll-out of a new technical system. However, it is also possible that collective opinion and news media tend to be pessimistic, emphasising things that do not work as promised. This could suggest that collective opinion can be a source that pushes back against the optimism of the proponents of megaprojects<sup>9</sup>.

## The Anna Karenina principle

In our study, we observed some common factors across the four projects and the two sectors, but we also found sector-specific issues that affect public opinion. These are largely typical to the sectors themselves, like budget cuts and lack of equipment and soldiers in the military, and disruptions in service due to weather, strikes, and engineering works in rail transport. However, Table 4.5 suggests a difference in the commonality of issues based on the two periods (rise or fall in public opinion).

We first notice that there are fewer reasons for a rise in public opinion as compared to reasons which lead to a fall in public opinion. Secondly, the former set of reasons are more likely to be either common to all projects or

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<sup>9</sup>However, whether public opposition can stop megaprojects in their tracks is not clear from our data, since the four projects in our study have been completed or are nearing completion. Serious problems have been reported with the armoured vehicles during acceptance trials as recently as the summer of 2021, and the programme may be scrapped, but this is not certain at the time of writing and the data collection only goes up to the end of 2019.

shared across the two sectors. The reasons for a fall in public opinion, on the other hand, are more in number, specific to sectors, and differ in their composition from one project to the next. That factors behind a rise in public opinion are common and few in number, but factors behind a fall in public opinion are relatively unique and more numerous to list chimes with the lines in Tolstoy's novel *Anna Karenina* – “*all happy families are alike; each unhappy family is unhappy in its own way*”. Researchers from different fields have termed this state as the ‘Anna Karenina principle’ (AKP) and have used it to explain success (but more commonly, failure) in a variety of fields like animal domestication (Diamond, 1994) and ecological risk assessment (Moore, 2001). We would like to introduce the idea to public management of megaprojects.

Over the long history of the megaprojects being studied here, there are times when public opinion towards projects is high (when the public and the project are a ‘happy family’) as well as when public opinion is low (the public and the project are an ‘unhappy family’). High public opinion is linked to the same issues across projects and across sectors, and perhaps these are necessary factors for a project to be considered successful by people (for example, the project boosts the manufacturing sector, leads to contracts, and achieves milestones). However, low public opinion is associated with various issues, some of which are specific to the sector or the project. The implication of AKP in our study is that megaprojects appear distinct and different during periods of low sentiment (when projects are struggling with challenges) but during periods of public satisfaction with the project, megaprojects experience similar positive issues. There are other variations of the Anna Karenina principle, notably Aristotle's articulation in *Nicomachean Ethics*<sup>10</sup> and the Second law of thermodynamics<sup>11</sup>, which also support our theorisation.

“We tend to seek easy, single-factor explanations for success, but for most important things, success requires avoiding many possible causes of failure” (Diamond, 1994, p. 4). A rise in public opinion is due to a few factors, many of which are common across projects, whereas a fall in public opinion is due to a number of factors, and some of them are specific to projects and sectors. We can attribute this to the complexity of major projects, the aforementioned ‘Black Swan’ characterisation, and the challenges of predicting sources of risk. Our findings contribute to this school of thinking as it shows that the composition of factors responsible for a fall in public opinion can vary from one project to the next. The presence of the Anna Karenina principle is a warning – a knowledge of critical failure factors is useful but not sufficient. Challenges come in different forms and there are many ways to fail.

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<sup>10</sup>“Again, one can miss the mark in many ways (since the bad belongs to the unlimited, as the Pythagoreans portrayed it, and the good to the limited), but one can get things right in only one (for which reason one is easy and the other difficult – missing the target easy, hitting it difficult). . . . For good people are just good, while bad people are bad in all sorts of ways.” (Aristotle, *ENII.6*, 1106a, trans. Crisp)

<sup>11</sup>Total entropy of an isolated system can never decrease, is constant if and only if all processes are reversible, and systems will innately move to a state of maximum entropy.

## 4.6 Conclusion

Megaprojects are an important feature of the economic and political world we exist in. They are large, complex systems that seek to address the large and complex challenges we face (national security, public transportation, public health, energy provision). Although existing research acknowledges the importance of stakeholder management and involving the wider community in developing and delivering megaprojects, there are few studies with public opinion as their central topic. Our study extends this currently small body of literature by studying public opinion on four megaprojects in the UK. To our knowledge, this is the first study that employs sentiment analysis to observe public opinion towards megaprojects over a period of fifteen years or more.

### Contribution

The study makes five contributions to knowledge. Firstly, the analysis of newspaper articles reveals the issues which concern the citizenry about megaprojects. All four projects are associated with the manufacturing sector, a sector about which people care deeply because of the role of such projects in regional economies, particularly through the creation of skilled jobs. Public opinion rises when projects perform well and falls when a project experiences uncertainty, delays, cost overruns, and technical problems. The issues raised and associated public reactions are largely consistent with the prevailing understanding of success and failure in project management. However, the inclusion of public opinion as a measure for project performance will reaffirm the place of democratic politics in megaprojects and offer some support to the arguments made by Willems and Van Dooren (2016) about ‘(re)politicizing’ policy on and management of public projects.

Secondly, our research finds that public opinion expressed in the media is fragile during the good times and prone to pessimism, which can perhaps make the public a potential source of resistance to the ‘optimism bias’ of project promoters. This finding is not as context-specific as one might assume – Zhang et al. (2018) looked at sentiment in China as expressed on social media and found negative events to have a stronger and more persistent effect on sentiment than positive events. Our empirical context (UK) is markedly different, and we study articles published in newspapers, but we too find that public opinion is more likely to experience sustained periods of decline than rise.

Thirdly, a comparison of factors that affect public opinion across different projects suggests the presence of the Anna Karenina principle – factors which lead to a rise in public opinion are few in number and often common across projects and sectors, but factors which lead to a fall in public opinion are more numerous and specific to sectors and projects. Therefore, while we may be able to predict the reasons for positive public opinion, the reasons behind negative opinion could vary from one project to the next and differ across

different sectors.

Fourthly, our research design shows us the public opinion trajectories for military and (civil) infrastructure megaprojects and makes a comparison not elsewhere fully explored in megaproject research. We note that the trajectories of projects can look alike across the two sectors, indicating that sentiment plots may be project-specific but not sector-specific. Additionally, while there are some military sector-specific issues that affect public opinion, we also find some common factors across the four projects.

Finally, our research makes a valuable methodological contribution by demonstrating the use of computer-based text analysis methods such as sentiment analysis to analyse large volumes of text data. Sentiment analysis of the kind we have conducted scores newspaper articles to facilitate temporal comparisons of collective media sentiment. Sentiment scores make it possible to identify peaks and troughs as well as turning points of opinion over time. By zooming in on the newspaper articles published at such points, it is possible to understand the issues discussed and associate the issues with both positive and negative periods.

## **Further work**

In this paper, newspaper articles have been exploited in a novel manner to understand the movement of public opinion over time. While the empirical context has been the UK which has a vibrant press culture, we think the methodology can be applied to study public opinion on megaprojects in other countries.

There are some exciting directions for taking this research further. Firstly, it will be worthwhile to look more closely at project actors. From the newspaper articles, we know ‘how’ megaprojects are discussed (the sentiment scores) and ‘why’ (the factors). It will be useful to add ‘who’ is talking about projects and referring to certain factors (local or global stakeholders, government or independent bodies, etc.). The actors themselves – citizen groups, civil society actors, politicians – may change over time, and an interesting question could focus on how such changes or internal dynamics interact with the bystander dynamics of wider public opinion.

Secondly, there is potential in comparing public opinion between military and civilian projects in greater depth than has been possible here. From this study, we know that the trajectory of public opinion across military and non-military sectors can look alike, but we cannot comment on the quality of public discourse and whether it differs between the two sectors.

Finally, we believe there is scope for improvement by increasing the accuracy of sentiment scores through machine learning and artificial intelligence. Our further work in this area is likely to adopt these methods as it allows extraction of greater meaning from textual data with speed and consistency.



## Contribution to the thesis

The comparison between military and non-military procurement is explicitly set out in the paper and the research contributes to answering the question ‘is defence different?’ in the domain of public perception. There appears to be no structural difference between the nature of public opinion towards defence projects when compared with public transport and civil infrastructure-related projects. Defence projects experience favourable and unfavourable media coverage over the course of the project. The legitimacy of defence procurement seems open to question and cannot be taken for granted. Amongst the newspaper articles mentioning the aircraft carrier, one can find headlines like ‘Forget the enemy: this carrier will sink our armed forces’ (*The Times*, 5 July 2014), ‘Ruling the waves?’ (*Yorkshire Post*, 23 May 2016), and ‘Royal Navy sunk’ (*The Daily Telegraph*, 10 October 2017). The same cynicism could not be found for the train projects (even when technological challenges delayed the programme).

Perhaps it would be more appropriate to challenge the assumption of ‘public legitimacy’ for defence by arguing that there actually exists an inherent scepticism about defence procurement of highly complex weapons systems unless a war occurs which calls upon the weapon system. For example, Alic (2007) writes how “an absence of warfighting experience ... leaves uncertainty concerning both the performance of weapons systems and the appropriateness of doctrine” (p. 22). This would explain why there had not been an equal degree of scepticism towards the procurement of armoured vehicles since these were being called into service for operations in Iraq and Afghanistan. Public opinion fluctuates for both defence and public transport projects. It would be disingenuous to say that defence perennially enjoys public legitimacy and is thus different from other fields and policy areas.



# Chapter 5

## Integrated discussion and contribution

“I would like to do an epic, a historical, a science-fiction ... I do not know if all this suggests a restlessness of mind, an indecision, a lack of direction, resulting in a blurring of outlook, or if there is an underlying something which binds my disparate works together.”

Satyajit Ray (Indian film director) in *Our Films, Their Films*, 1976, p. 63

The papers are bound together through the research framework proposed in Chapter 1. An accurate description of the core chapters of the thesis (Chapters 2, 3, and 4) would be a triptych. Like the three panels in a triptych, each chapter is a paper that can be displayed independently. In fact, they are. The first paper was published in *Science and Public Policy*, a journal which publishes research on public policies in science, technology, and innovation; the second paper is relevant for operations management research; the third paper engages with existing research in public management. Nevertheless, when the papers are displayed together, they are connected by some common themes, complementing each other in a knowledge triad, contributing answers to the thesis question and sharing methodological assumptions.

This chapter aims to provide a cross-cutting discussion of the three papers and a consolidated narrative which integrates the papers within the research framework. This chapter also synthesises the contributions of the research work presented in the preceding chapters for answering the overarching research question ‘is defence different’.

This chapter contains three parts. The first section explores the plurality and complementarity of the multiple perspectives employed in this thesis. The second section discusses the essential similarities in the methods pursued. The final section highlights the dimensions along which the three papers answer the question ‘is defence different?’. Each section also represents the main contributions of the thesis. The first section gives an ontological framework for studying public procurement and innovation. The second section describes methodological novelty and methodological contributions of the thesis. The

final section provides insights gained from examining defence and non-defence public procurement contemporaneously.

## 5.1 A triadic approach to knowledge

The research framework proposed in Chapter 1 (Fig 1.4) suggested three directions of enquiry regarding the question ‘is defence different’, based on a review of existing research. Defence procurement is assumed to be different based on theories of procurement and technology development, practical and operational aspects of procurement, and the political environment within which procurement takes place. The research which took place during the course of the doctoral project sought to address each category of assumption, and although the research outputs created (the three papers) are distinct, they are not disjointed, as they are based within a threefold framework of knowledge.

A triadic approach to knowledge combines thoughts, words, and actions to understand experiences and phenomena. This thesis seeks to do the same for the apparently axiomatic belief that defence is different and the three papers help in achieving this through their different perspectives and by being complementary to each other. Moreover, the thesis combines perspectives from different quarters – from academics (Chapter 2), from practitioners (Chapter 3), and from the wider public (Chapter 4).

### Different people

Each paper examines the research question with different people and communities. In the first paper, the academic community which engages with public procurement and innovation research is identified through a systematic literature review. In the second paper, the focus shifts to those involved in the procurement process — officials in government departments, members of the industry and those on the supply-side, and MPs in select committees. The third paper looks at public opinion and takes a wider view of people who are interested in procurement projects.

All these different people are critical to our understanding of whether and how defence procurement is different. The question of the thesis – is defence different? – was inspired by an initial exploration of academic work that discussed public procurement as a demand-side innovation policy tool. This led to questions about the wider literature on public procurement and innovation – do researchers in the field consider defence to be different? But the question can also be posed to public procurement practitioners and the wider public as well – do they hold similar assumptions about the peculiarity of defence procurement?

Some of the early explorations on the role of public procurement in promoting innovation started with an interest in industrial innovation and technological change (Pavitt and Walker, 1976; Mowery and Rosenberg, 1981; Rothwell,

1981; Nelson and Langlois, 1983; Mowery and Langlois, 1996) and noted the importance of public procurement activities. There was also an interest in comparing innovation policy instruments which noted the efficiency of procurement (a demand-side or ‘pull’ policy instrument) over supply-side or ‘push’ style policy instruments like subsidies (Rothwell and Zegveld, 1984; Geroski, 1990). The efficiency argument becomes particularly relevant during periods of low economic growth when there are heightened demands on public spending to boost economic activity (OECD, 2011). Countries try to achieve more from public procurement and try to pursue strategic and innovation-friendly procurement policies.

It was important to look at academic work through a systematic review of the public procurement and innovation literature (Chapter 2) to learn whether and how defence procurement differs from civilian public procurement when discussing the role of public procurement in innovation. Defence procurement is discussed as a possible illustrative case of innovation procurement by many researchers (like Mowery, 2012; Caldwell and Howard, 2014; Alic, 2015). One of the early works in the literature (Mowery and Langlois, 1996) describes the role of US federal government policies, including military demand, in the development of the US computer software industry. Whether researchers in public procurement and innovation consider defence to be different may have implications for the theories of procurement and innovation that are applied to the defence sector (the first pillar of the framework). Therefore, the first research direction involved the examination of existing research.

To examine the practice of public procurement (the second pillar of the research framework) and note whether defence procurement operates differently, I thought it would be more relevant to look beyond academia and examine the views of procurement officials and supply-side managers and industry executives. Public procurement researchers usually consider buyer and supplier perspectives when studying the procurement landscape, so it only seemed natural to look for such actors for my study. The empirical context – four projects listed in the UK’s Government Major Project Portfolio – prompted me to find the persons who had been associated with the projects from the position of users, procurers, or suppliers. Besides looking for project leaders and managers, I was also interested in auditors and those who assess public projects on behalf of the public. Therefore, the second paper (Chapter 3) focuses on those involved in the more practical and operational aspects of public procurement.

For the third pillar of the framework, which emphasises on the political environment and public perception of defence procurement, it was imperative to cast the net wider in identifying people interested and invested in the projects. Including the wider public was especially important, considering that this research is based in humanities and the social sciences, which valorises the experiences and thoughts expressed in society. Large public projects are typically resource-intensive and often politically controversial, generating opinion among the general public because of their public and political nature (Willems and

Van Dooren, 2016) and their substantive and wide-ranging impacts (Walker, 2000). Chapter 4, therefore, addresses this requirement by looking at wider public opinion towards projects. The wider public was captured by collecting newspaper articles from every major UK newspaper for the projects under study.

These different people – academics, practitioners, and the general public – are integral to the research framework and for constructing a comprehensive, multi-dimensional response to the research question. The different perspectives used for studying public procurement and innovation make it possible to respond to the question of the peculiarity of the defence sector from different positions. Furthermore, the different actors are connected to each other in the process of public procurement. Researchers observe practitioners and the public, practitioners gain knowledge and insights from research and the wider public, the public is guided by experts or academics, and so on. In Chapter 2, while reviewing the public procurement and innovation literature, there is a discussion of how the growth in academic work itself is closely linked to the participation of academics in policymaking circles (see section 2.3). This makes it Thus, it is critical to include all of them in a study of public procurement.

## **Different sources of information**

The three papers draw on different data sources, which is largely linked to the nature of the community under focus. Chapter 2 looks at researchers and academics and therefore uses journal articles, a common method that researchers use to share theories and ideas within the research community. Research work published in journals usually undergoes a peer-review process and thus published works demonstrate quality as well as acceptance. Similarly, the opinion of the general public is captured through newspaper articles which not only include news reports but opinion pieces, commentaries, and letters to the editor (see section 4.3 for literature on the close links between media and the public). The data from newspaper articles is very unstructured as compared to journal articles, but this adds to the variety of information analysed to answer the main research question.

Chapter 3 focuses on procurement personnel, project managers, suppliers, and auditors and many researchers conduct interviews with key informants and relevant people to gather data. However, I discovered some problems in adopting a similar approach for my study. The primary issue with identifying and talking to people who were associated with the projects is that they may not be able to offer a dynamic view of the project. Large public projects, as has been noted earlier, are characterised by long periods of development and delivery. Interviews could therefore struggle to capture what was happening to the project in the past – interviewees might revise their responses with the benefit of hindsight. I also found from documentary analysis that the tenure of civil servants was independent of the projects, meaning that a project could see three or four different project managers over its course. Finally, interviews

are an extremely expensive method of gathering data, and I was unsure about my ability to access senior civil servants and industrial executives and collect meaningful information within the time constraints of the doctoral project.

While searching for different kinds of publicly available data on the selected public projects, I came across parliamentary select committee hearings, and they appeared attractive for three reasons. Firstly, select committee hearings took place at different points in time across the long project lifecycle and recorded thoughts and concerns *in situ*, rather than providing a retrospective view of the project. Secondly, the discussion at select committee hearings could get very lively, especially when many people were involved. An interview might not generate such an open and interactive environment. Most importantly, hearings are a rich source of data on institutional logics (Suddaby and Greenwood, 2005) and thus was a good fit with the theoretical foundations of Chapter 3.

Although a variety of data was used in this project, they are all secondary sources of information, in the sense that the data was not created with the research question ('is defence different?') in mind. This is perhaps a limitation of this project, although it also confers some advantages. For example, the different sources of data generated by different types of people provide an insight into their inherent and underlying thoughts. Beyond the explicit statements about the similarities and differences of defence, the different data sources (particularly the hearings and newspaper articles) make it possible to investigate whether there are any structural differences in the treatment of defence procurement, as opposed to non-defence public procurement. Directly asking people to consider the question 'is defence different?' might force them to take sides. However, indirectly exploring the question by carefully examining conversations that took place over the course of selected defence and non-defence procurement projects allows exploration at a deeper level, where people can reveal nuances in their position regarding the question 'is defence different'.

## 5.2 The importance of words

The three core chapters differ substantially from each other in data and analysis methods, primarily because of their theoretical backgrounds and research questions. However, in all three papers, it is assumed that words are important, and methods and analysis techniques are connected by a motivation to extract greater meaning from textual data.

Words facilitate communication and convey meaning and reason. They are conventional linguistic expressions that can be studied as single units or as conglomerates (i.e., a system of words or vocabulary), and are used by groups in a social world to communicate, think, and act (Loewenstein et al., 2012). In Chapter 2, journal articles are the sources of text data. Publishing in academic journals is one of the ways in which academics express their thoughts

on a subject. In Chapter 3, transcripts from parliamentary select committee hearings are used, a setting where key stakeholders in public procurement express their points of view on the project's progress and development. Chapter 4 uses text from newspaper articles which constitute an important forum for public expression and opinion.

## Text analysis techniques

A variety of text analysis techniques have been used in this thesis. In the first paper, articles were read and coded manually, with the help of a coder manual. The development of the coder manual was an iterative process. It was guided by the methodology and appendices of Jones et al. (2015), but had to be adapted to the requirements of the topic under study. Seven highly cited articles from the corpus were first coded to see if the coder manual was adequate, and the process was repeated with a few more articles until the coder manual could be finalised. A subset of papers was randomly selected and coded by both supervisors (the co-authors of the paper). The responses were compared to find inter-coder agreement, which helped to confirm the coder manual's reliability.

Some points of analysis, like the analysis of abstracts, required the use of a semantic analysis software like *Cortext* to assist with the identification of research communities. The terms extracted from the ninety-nine abstracts were built into a network using the Louvain method (see Blondel et al., 2008), which placed the terms in clusters using an optimisation function. The terms are first placed in their own community (i.e. the number of clusters is the same as the number of terms) and each iteration places terms in different clusters until the density of edges (documents) connecting the terms within a cluster is maximised against the density of edges outside clusters.

When working with the transcripts of hearings in the second paper, there was again an analytical requirement to find connections between documents (speech acts) based on words contained within. Words and vocabularies are an indicator of institutional logics, and the research objective was to note whether different parties involved in the procurement process had preferences for certain words or vocabularies (thereby reflecting their logics). A homogenous network mapping of terms (as done previously) would not have fulfilled this objective – it was important to discover word systems or vocabularies within a document and note its prevalence in the wider corpus, all the while preserving metadata like the professional identity of the speaker.

Topic modelling was therefore used to discover topics within the text. The word 'discover' is used because topics are not pre-defined. Topic modelling is an automated and inductive technique for text analysis, combining the ease of machine assistance to analyse large volumes of text and avoiding the imposition of researcher's knowledge and assumptions before analysis (DiMaggio et al., 2013). The semantic coherence of a topic (and, more broadly, the model)



is judged by the machine by considering the frequency of co-occurrence of the most probable words in a topic (Mimno et al., 2011). Although human judgement is still necessary to choose a specific model over others, the entire task is easier to explain and replicate.

Hearings create an environment where participants seek to present their key arguments and points of view on a case. This makes transcripts from hearings an important source of data for institutional logics (Suddaby and Greenwood, 2005). Topic modelling of such texts, therefore, provides valuable insights on prevalent vocabularies. Using topic modelling on transcripts from select committee hearings made it possible to attribute topics to the speech acts of different participants in the public procurement process – government department officials, members of industry, MPs, etc., and then note the incidence of topics, or topic prevalence, for each group.

Moving onto the third paper, where the aim was to measure public opinion, text analysis incorporating attitude or sentiment became necessary. Sentiment analysis is the computer-based analysis of texts to extract the emotions and attitudes of the author (Stieglitz and Dang-Xuan, 2013). It is a relatively recent method of interpreting text and is still being developed by computer scientists and linguists under the aegis of artificial intelligence and machine learning. Machines are taught the meaning of words and learn to interpret a block of text and determine the emotion being conveyed. In many instances, researchers from different fields are assisted by computer scientists and linguists to train algorithms to understand human speech and text relevant to their field. In this manner, artificial intelligence has been well-trained to understand product reviews and help marketing research (Guha and Kumar, 2018; Lau et al., 2018).

There exist some popular and widely-known dictionaries or lexicons for sentiment analysis, like Bing (Liu, 2012), *afinn* (Nielsen, 2011), and NRC (Mohammad and Turney, 2015) which differ slightly in their aims – Bing and *afinn* give scores to words while NRC maps words into eight non-exclusive categories of emotion based on Plutchik (1980). The construction of a dictionary and subsequently a software for sentiment analysis is a resource-intensive exercise – both the creation of dictionaries and validation of the machine’s interpretation are performed through large crowdsourcing experiments. When this is not possible, researchers use a readily available lexicon, which can affect the accuracy of sentiment analysis, especially if the researcher’s text contains some specific writing style. For example, determining sentiment from speeches made in the UK parliament is challenging because of the specificities of parliamentary language (see Abercrombie and Batista-Navarro, 2018). In this research, *sentimentr* developed by Rinker (2017) was used. The reliability of sentiment analysis was established through a manual cross-checking exercise involving three human coders (described in section 4.3).

Each technique is attuned to the research requirements of each paper. Col-

lectively, they demonstrate the ability to exploit textual data structured in different ways (academic articles, hearings, and newspaper articles), to provide a variety of outputs and answers like the co-occurrence and proximity of texts to each other, vocabulary preferences of speakers, and emotions and sentiments of authors.

## Methodological novelty

There are certain elements of methodological novelty in this thesis. Incorporation of text analysis in systematic literature reviews is fairly uncommon (Chapter 2), topic modelling has been used recently in research on institutional theory but not in conjunction with a study of public procurement processes (Chapter 3), and machine-assisted sentiment analysis for the study of public projects is rare (Chapter 4). The new methods are especially appealing for their codification of research. My research is based on sources of data that are publicly available. Systematic data collection strategies (described in the chapters with further details in the appendices) make it possible to replicate the studies conducted within this doctoral project. The methods extend this philosophy into the analysis phase.

The use of sentiment analysis was the most challenging (as well as the most exciting) methodological conundrum. On the one hand, there was very little existing research on public projects that applied sentiment analysis. This was not particularly surprising – public opinion is itself a challenging and inadequately addressed topic in project management research. Desai (2014) uses content analysis to estimate unfavourable media coverage and manually rates 705 news articles. Additionally, agreement between human coders was higher than the agreement between machine scores and human beings (although not significantly so) in the paper (see Table 4.2). While this may be an argument for manual annotation, the third paper would have required manually annotating 5,710 newspaper articles for public opinion, which was not feasible.

However, using computer-based techniques helps in replicating research and makes it easier to identify underlying assumptions in a research project. This is especially valuable for research on public opinion, where implicit researcher bias can affect data analysis and conclusions. By using dictionaries, software packages like *sentimentr* make the process of assigning sentiment scores to text transparent and replicable. The accuracy of such techniques can be improved over time as machines are exposed to more material related to the topic.

Machine learning teaches us a lot about how we learn, understand, and interpret words and texts ourselves. For example, while comparing inter-coder agreement between human coders and the machine's scores, there were instances where the use of sarcasm had not been picked up by the machine as an expression of negative public opinion, whereas all three human coders concurred in their ranking of articles. It is hoped that in the near future, more researchers in the field of public projects will experiment with sentiment anal-

ysis and improve the ability of computers to understand texts related to the topic. The development of better sentiment libraries to account for the intricacies and nuances of language used to talk about public projects represents an important and promising area of research. Accurate sentiment analysis of texts relating to politics, economics, and society would allow researchers in these fields to benefit from new technologies and open more avenues for applying natural language processing and machine learning. More broadly, the methodological contribution of this thesis lies in demonstrating the use of new techniques of exploiting data to answer old questions.

### 5.3 Is defence different?

The research framework organises the assumptions about the distinctive or peculiar nature of defence in three categories – theories, practice, and perception. Based on the research work conducted in the previous chapters, this section provides a consolidated response on whether defence procurement is different along these lines.

#### Theory

There is limited engagement within the public procurement and innovation literature with questions of sectoral differences, such as whether defence is different. Of the seventeen articles in a corpus of ninety-nine papers, eleven do not acknowledge or mention any peculiarities of defence procurement. Of the papers which delve into the question, some reasons are provided on what makes defence different – imperfect markets, the prevalence of cost-plus contracts, greater public legitimacy, to name a few. However, these do not stand up to systematic or close empirical scrutiny, as demonstrated by the empirical evidence of Chapters 3 and 4.

There appears to be no consensus on whether defence procurement requires different or exclusive theoretical treatment. For example, one of the reasons for considering defence to be different is the argument that the defence market is uncompetitive<sup>1</sup>. However, even within existing research, it is acknowledged that the military is not the only sector of the economy that experiences imperfect market conditions (Heinrich, 2002; Caldwell and Howard, 2014). Howard and Caldwell (2011) explicitly note that oligopolistic markets are a feature of complex product systems where “often the first responsibility of the buyer (usually the government) is to create a market”, and how “the UK government in particular, through various outsourcing and public-private contractual mechanisms, has had to create new markets for complex procurement, most noticeably in healthcare, public transport, and defence” (p. 11).

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<sup>1</sup>“Rather than competing firms serving markets of autonomous consumers or firms, whose independent purchase decisions influence price, profitability, entry and exit; military R&D, and related transactions involve limited competition among a small number of firms (often very large firms) selling to a single customer. The operation of competitive forces within this arena is managed by the buyer” (Mowery, 2010, p. 1235).

Therefore, it is not clear whether defence procurement is different from public procurement of complex systems in the civilian domain. It is important to place sufficient emphasis on the complexity of technology here. Innovation procurement might not differ between the defence and civilian sectors of the economy as much as it (innovation procurement) could differ from procurement of standardised items (or ‘regular procurement’). Existing research on complex product systems stems from an interest in innovation processes and innovation management (Davies, 1996; Hansen and Rush, 1998; Hobday, 1998; Nightingale, 2000; Davies et al., 2012) and seeks to characterise the design, development, and delivery of these systems, irrespective of industry or economic sector (defence or otherwise).

Complex products and systems (CoPS) take a long time to develop (Gil, 2007; Du et al., 2015; Hsuan and Gobbi, 2015), and this leads to designing such systems under high levels of uncertainty (Davies et al., 2012). There is high variability among such projects in adhering to cost estimations and time schedules with a tendency for poor cost and schedule performance (Nightingale, 2000). The development may also involve institutional and social commitments that produce inertia, making it difficult to stop the CoPS juggernaut when it gets started (Walker, 2000). The market for CoPS is best described as a bilateral oligopoly where there are few large firms supplying to a few large buyers (Davies and Brady, 1998). Most importantly, examples of CoPS include items that can fall under both defence and non-defence public procurement (Hobday, 1998, p. 697) (Hobday, 1998, p. 697).

## Practice

Does public procurement differentiate between defence and non-defence procurement in practice? Based on the empirical evidence from Chapter 3, the response is a qualified ‘yes, and no’. Defence is different from public transport (the civilian sector under consideration in this thesis) when the relations between various actors in the public procurement process are considered. Differences in language and vocabulary choices are greater in the field of defence. Since differences in language are an indicator of different institutional logics, the evidence suggests that the institutional environment in defence procurement is more institutionally heterogenous. Institutional differences and institutional complexity are commonly associated with frictions and conflict (Mahalingam and Levitt, 2007; Meehan et al., 2016; Stenius and Storbjork, 2020); thus, defence procurement may have a higher likelihood of experiencing institutional conflict.

However, there are also some similarities between the procurement landscapes. The topic modelling exercise led to the discovery of commonly used vocabularies, and besides some sectoral specificities, both topic models had some common topics like costs, accountability, and project management concerns. The transcripts of select committee hearings also showed that procurement of trains also involves “defence-style” management contracts (Committee of Pub-

lic Accounts, 2013, Q155) and calls for adopting a more strategic perspective towards industrial implications of procurement (Transport Committee, 2011, Q106). Defence procurement in the world of practice does not appear to be entirely exceptional or unique.

## Perception

The most interesting aspect of exploring whether and how defence is different is related to public perception – do people perceive defence procurement differently? Sentiment analysis of a wide array of newspaper articles on four public procurement projects in the UK (two from the defence sector and two from public transport) suggests no structural differences. Public opinion fluctuates over the long lifetime of projects, going through peaks and troughs. The sentiment plot may have several peaks and troughs, or it may be U- or V-shaped with one significant trough. The shape of the plot seems to be project-specific rather than sector-specific (Fig 5.1).

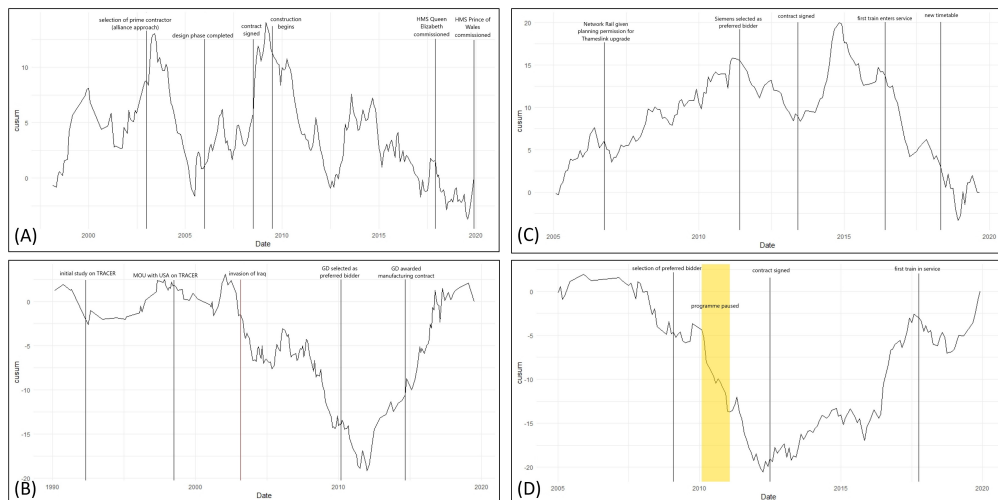


Figure 5.1: Sentiment plots (reproduced from Chapter 4) of (A) Queen Elizabeth programme, (B) Armoured Cavalry 2025, (C) Thameslink Programme, and (D) Intercity Express Programme

Defence projects do not appear to be enjoying greater public legitimacy or immunity from criticism. All four projects faced critical technological problems, and concerns were voiced about the viability of the systems being procured. In particular, the press carried highly critical articles of the aircraft carrier from the early stages of the project, with headlines like “Following the Americans up and down the Gulf scarcely justifies us spending billions on new aircraft carriers” (*The Guardian*, 9 July 1998).

Although it has not been possible to compare the quality of public debate and discussion, from a public management perspective, the wider public appears to be capable of identifying key project management issues for both military and civilian projects. Technological challenges, problems with lowest price bidding, and political uncertainty are all noted in newspaper articles. This is linked to the discussion of the public as a barometer for projects (see section 4.5).

Public opinion demonstrates some common characteristics across the four projects. Public opinion appears to be cautious and wary, quick to turn negative when projects go wrong, while project successes do not sustain positive opinion for long. In fact, as explained in Chapter 4, the relationship between public opinion and public projects can be explained with the Anna Karenina principle. The factors associated with periods of high public opinion are common across projects and few in number while the issues associated with periods of low public opinion are varied and more numerous. There are many ways to lose public favour, some common across sectors and projects (job losses in the manufacturing sector, technical issues), while others may be more specific (see Table 4.5).

Overall, defence is different, but not peculiarly so, and there is much to be gained from studying defence and civilian procurement side-by-side. Comparatively studying procurement projects and sectors reveals areas of commonality, shared experiences, and opportunities for shared learning.

# Chapter 6

## Conclusion

The final chapter of the thesis provides a summary of the project, expands on the research strategy, critically evaluates the limitations of the thesis, and indicates directions for future research. It allows an extended discussion on the research journey that is essential for theses but cannot be made explicitly in other chapters of a journal format thesis, mainly due to the nature of the core chapters, which are structured as journal-style research articles.

### 6.1 Summary

Governments around the world and at different levels purchase goods and services to fulfil functions like national security, public health, transportation and mobility, environmental protection, and generally support their citizens in different spheres of life. This purchasing activity, commonly known as public procurement, is often positioned as a strategic policy tool for fulfilling wider objectives. A growing body of academic literature as well as government policy interest can be found on the topic of innovation procurement, i.e., the use of government's purchasing power to support innovation and technology goals in society.

Public procurement is an important 'demand-side' innovation policy instrument, and yet there is a tendency to avoid the study of military demand or defence procurement (Edler and Georghiou, 2007; Weiss, 2014). There is an assumption that defence procurement is different from public procurement in non-defence sectors, and this assumption appears to be almost axiomatic, going unchallenged without a detailed examination of what is different about defence. The aim of my doctoral project was to challenge this assumption and study defence and non-defence public procurement comparatively. This research was motivated not only by the lack of engagement among innovation procurement researchers about the question (a gap in knowledge) but also because the assumption placed defence in a silo, separated from the broader field of public procurement and innovation (a problem).

Defence is assumed to have some peculiar characteristics, like the market

within which it operates, the propensity and capacity of absorbing technology, legal and organisational rules, and institutional and political environments, to name a few. These assumptions are elaborated in greater detail in Chapter 1 (section 1.1) and were used for creating a comparative framework for studying military and civilian public procurement together (Figure 1.4). The framework has three dimensions – theory, practice, and perception, and each has been explored within a separate research paper (Chapters 2, 3, and 4, respectively). The papers are summarised below, and the consolidated response based on the findings of the paper can be found in Chapter 5 (section 5.3).

## **The first paper**

The first paper presents a systematic review of the public procurement and innovation literature. Reference to different economic sectors in the existing research was noted by observing the function of government that public procurement aimed to fulfil (Table 2.5). The functions of government fulfilled through innovation procurement go beyond defence and include several non-military purposes like environmental protection, health, and civil infrastructure.

A corpus of ninety-nine journal articles in English was manually coded across a range of variables, following a coder manual (appendix A.1). The information was used to document the evolution of the public procurement and innovation literature, highlighting its dominant and overlooked themes. Analysis of keywords and abstracts suggested some broad boundaries of the research field. Industrial development, environmental innovation, and regional and local-level procurement are some of the popular themes for innovation procurement research. The diversity of themes and empirical contexts is increasing over time, although this introduces challenges in consolidating the research on this topic. A variety of terms are being used to describe innovation-friendly public procurement and it may be difficult to consolidate knowledge in a fragmented field without more theoretical and conceptual work.

The research related to the first paper made a number of contributions to the thesis. It identified research papers that mentioned defence procurement and closely examined their discussions on the question of defence procurement being different. There were six papers which listed characteristics like the use of cost-plus contracts (Rothwell, 1984), oligopolistic market structure (Caldwell and Howard, 2014), a more favourable political environment (Nelson and Langlois, 1983), an overriding preference for highly technical solutions (Dalpé et al., 1992), and the specificity of requirements preventing spillovers into other sectors (Rothwell, 1994; Markowski et al., 1997). These assumptions were kept in mind while examining the empirical evidence in the next two papers.

The literature review also revealed some of the concerns associated with implementing innovation procurement, and a key concern was regarding the operation of procurement in an imperfect market. Innovation-friendly or strate-



gic procurement moves beyond price competition and attempts to take non-pecuniary costs and benefits into account (like technological advantage, social value, and sustainability). Procurement in such markets is transactionally complex, and procurement researchers have used different theoretical lenses to understand the sources of frictions in the public procurement landscape. One such theoretical lens is institutional theory, which forms the theoretical basis of the next research paper. The observation regarding defence enjoying greater public legitimacy inspired the third research paper. Thus, the first paper helped to generate questions for the second and third papers in this thesis.

## **The second paper**

The second paper looks at public procurement in practice, focusing on individuals and organisations that participate in the public procurement process in various capacities, for example as government officials, industrial executives on the supply-side, project managers, auditors, and public representatives. Defence procurement is compared with civilian public procurement by examining the institutional landscape and the levels of institutional heterogeneity in two fields – defence and public transport (i.e., a non-military or civilian field).

Institutional theory claims that individual and organisational behaviour can be explained by the existence of deeply-held beliefs or logics (Friedland and Alford, 1991). Institutional logics can be detected by looking at resource environments, regulations, and symbolic representations like theories, frames, narratives, and vocabularies of practice. In the paper, vocabulary preferences of the different professional groups associated with procurement are noted to make comments on the institutional landscape.

The text data for detecting vocabulary preferences comes from transcripts of select committee hearings. Select Committee hearings are a setting where different expert groups are invited to present their perspectives and evidence to a Committee of Members of Parliament. In the case of public procurement projects, various actors involved in public procurement present their perspectives on major projects as part of the UK's practice of Parliamentary scrutiny of government policy. Topic modelling of texts related to four procurement projects (two defence projects and two public transport projects) reveals significant differences in vocabulary choices of the different professional groups. However, institutional differences appear to run deeper in defence. Key professional groups (department officials, industrial executives, and MPs) display different preferences over a greater share of prevalent vocabularies or topics (Table 3.7). Different vocabulary preferences not only indicate different institutional logics but, in the case of this paper, suggest that people are not using the same language and talking past each other.

Overall, this paper presents interesting empirical evidence on public procurement in the realm of practice and practitioners. From the point of view of the

thesis, the transcripts provide some interesting statements from politicians and public servants about defence procurement which express similarities between defence and non-defence public procurement. For example, it is revealed that complex contractual arrangements were made to procure rolling stock in the Thameslink and Intercity Express Programme, which were similar to contracts used in defence procurement (Committee of Public Accounts, 2013, Q155). Further, there are suggestions for thinking more strategically about rolling stock procurement, drawing from the procurement experiences and philosophy commonly associated with defence procurement (Transport Committee, 2011).

## **The third paper**

The third paper in this thesis is based on sentiment analysis and seeks to capture public opinion towards public procurement projects. Public procurement is not just a transactional economic activity, but also a political activity and procurement projects generate opinions and are also affected by the opinions they generate. Public procurement with a significant innovation component takes a long time to develop and become operational in both the military and the civilian sphere. The objective was to note whether public opinion changes over time and understand the factors behind changes. Comparing public opinion on defence and civilian procurement addresses one of the most interesting assumptions about defence procurement, i.e., the perception of defence procurement in the wider public.

Sentiment analysis is an automated text analysis technique that uses a lexicon-based approach to assign a score to texts based on the sentiments expressed, ranging from 1 (highly positive) to -1 (highly negative). This technique was applied to thousands of newspaper articles published in the UK over a period of 15 years or longer regarding four major public procurement projects (two military projects and two civilian projects). The sentiment scores were plotted across time to observe the movement of public opinion and the figures were used to note peaks and troughs in sentiment towards the projects, identifying events and stories associated with positive or negative opinion.

The study helps to increase the understanding of public opinion in project management and note how public opinion changes over time. The issues which are associated with the rise and fall in public opinion are similar to the critical factors identified by researchers to explain project success and failure, and thus the public can be a barometer for project performance. The study also finds that sentiment is fragile, prone to pessimism and caution, which makes it a potential source that pushes back against the dangerous over-optimism of project managers and project promoters. It is also interesting to note the Anna Karenina principle at work – when the public is happy about projects (when positive public opinion is prevalent), the reasons are few in number and shared across projects, while when the public is unhappy about projects (negative public opinion is prevalent), the reasons are more numerous and

often unique to projects.

Between defence and civilian public projects, there appear to be no structural differences in public opinion. The public has positive and negative opinions on both defence and non-defence projects. Sentiment plot trajectories are project-specific, not sector-specific. There are some sector-specific issues characterising periods of high and low public opinion, but there are some common issues as well. Therefore, from a project management perspective, there is potential for both shared and sector-specific training and learning. The Anna Karenina principle is a warning – success is based on similar reasons but there are many ways to fail.

## 6.2 Research strategy

A multi-pronged strategy was pursued to address the question of similarities and differences in defence procurement and innovation from distinct points of view. Together, the three directions cover the spheres of academia, practice, and perception. The multi-pronged approach also gives flexibility in the choice of research methods. While the empirical context for research was the same for the second and third papers (four UK procurement projects), the sources of data were different (select committee hearings in one, newspapers in another), as were the methods of analysis (topic modelling and sentiment analysis). The UK was a realistic choice of country for the study because the government actively engages in the procurement of highly complex technological items (it is the most popular country for the study of public procurement and innovation in the corpus reviewed in Chapter 2, see Table 2.7). Since defence procurement takes place at the national level, the level of government studied was also restricted to the national level. Thus, non-defence procurement by the central government was considered for comparison rather than procurement by regional or local public authorities.

The University’s guidance on journal format theses suggests sharing experimental aspects of the research design that would normally be a part of a discursive monograph but may not feature in published chapters or chapters intended for publication in alternative format theses. This section briefly recollects the ‘roads not taken’ and the ‘dead ends’. In a temporal framing, this section draws from my second-year research diary (2018-2019). While the first year had been spent purposefully working on a systematic literature review, the second year was much more exploratory, alternating between theoretical and empirical investigations.

### Research questions

The systematic literature review had indicated that public procurement and innovation research lacked adequate discussion on, and consensus about, theoretical bases. This created some challenges in defining the dimensions along

which defence and non-defence public procurement could be compared to answer the question ‘is defence different?’. The exemption of defence in WTO’s GPA suggested the use of procurement law as a dimension for comparing military and civilian procurement. The legal perspective was not pursued because using explicitly stated law as a comparator seemed restrictive. Secondly, but perhaps of greater importance towards the decision, was the fact that my prior training was not in law but economics.

The review of various literatures (procurement in imperfect markets, complex product systems, and megaproject management) suggested three dimensions for comparison – competition, risks, and management. Table 6.1 provides the elements of each dimension. The framework was proposed by observing the dimensions investigated in existing research on the topics. Because the existing research often used procurement projects as case studies, the unit of analysis for this framework is also projects.

Table 6.1: Dimensions for studying public procurement of complex product systems

<b>Competition</b>	<b>Risks</b>	<b>Management</b>
Procurement process	Technological	Structure of project team
Number of competing bids	Contractual	Project managers/leaders/CEOs
Selection/evaluation criteria	Organisational	Governing bodies
Regulation	Political	Project review and documentation

The elements in the first dimension (competition) relate to the first stage in the public procurement process where the government agency sets out the requirements by issuing a tender, potential suppliers respond to the tender, and a winner is selected and awarded the contract. The procurement process may differ according to the level of competition – for example, it may or may not be competitive, international suppliers may or may not be invited. The number of competing bids is also an indicator of the level of competition in the market. The evaluation criteria and regulations related to procurement are also important dimensions that affect the selection of supplier.

Risks related to the procurement of complex product systems can be of a technological nature (stemming from technological complexity and design issues), or contractual (relating to the complex contractual arrangements that are prevalent in such cases). Risks can also be organisational, relating to limitations of organisational capacity and skills, or political, emerging from the wider political and institutional environment in which the project exists. The elements in the management dimension include the organisation and structure of the project team, the scope, experience, and turnover of project leaders, the existence and role of governing bodies, as well as practices of project review and quality of documentation. At the end of the second year, the research proposal sought to compare defence and civilian public procurement projects along this framework.

However, the framework was ultimately not used. This was primarily because it arrived too late and the data collection requirements for its execution appeared infeasible. Additionally, the dimensions were still quite broad and required further refinement for operationalising theories and concepts. A wider review of literature, as well as more conceptual creativity, was required to devise an operationalisable research framework that would be suitable for answering the comparative question and also demonstrate coherence of thought. It is with this in mind that an alternative framework was developed (Figure 1.4). The chosen framework, presented in Chapter 1, is directly based on the observations in the literature about what is different about defence and organised along dimensions that convey a more comprehensive response to the research question, addressing different communities – academics, practitioners, and the wider public.

## Selection of projects

The *Government Major Projects Portfolio*, published annually since 2012-13, lists major projects being pursued by different departments and includes commentaries about their progress. When I started looking for UK projects to study, GMPP 2017-18 had just been published. There were 133 projects to choose from, but a preliminary examination led to the rejection of several projects for not having a significant procurement component (e.g., policy implementation, organisational changes within departments) or procurement of commercially available products. Projects with international collaboration were also rejected to avoid cross-cultural differences from contaminating the comparison between sectors.

Nine projects were shortlisted – five Ministry of Defence projects, two from the Department for Transport, and one each from the Department of Health and Social Care and the Home Office.

1. Armoured Cavalry 2025 (MoD)
2. Marshall (MoD)
3. Dreadnought programme (MoD)
4. Queen Elizabeth programme (MoD)
5. Type 26 frigate (MoD)
6. Thameslink programme (DfT)
7. Intercity Express programme (DfT)
8. National Proton Beam Therapy Service (DHSC)
9. Immigration Platform Technologies (Home Office)

During supervisory discussions, I was warned against studying the Dreadnought programme. The project involves the procurement of submarines that will deliver the UK's only form of nuclear deterrence. The strategically unique position of the project could make gathering information extremely difficult. Therefore, the project was removed as a potential case study. Type 26 frigate programme was classified as 'exempt' in the GMPP from 2012-13 to 2016-17 and was also removed because of similar concerns.

Project Marshall and Immigration Platform Technologies were both software and IT-intensive projects. Davies and Hobday (2005) discuss complex product systems and suggest a distinction between manufacturing and ICT (information and communication technology) projects – the latter face greater uncertainty and technical difficulties. Due to the time constraints of the PhD programme, the two ICT projects were initially parked aside and ultimately not pursued within the doctoral project.

While gathering more information on the projects, I realised that while it is usual for major projects to require a great degree of customisation (a long 'design phase' when project objectives are articulated), the National Proton Beam Therapy project (development of centres to provide patients with radiation treatment) was missing this characteristic. Despite involving the procurement of a niche, expensive, and technologically intensive equipment, this lack of customisation made it slightly less complex than the other projects. Ultimately, four projects remained for study – armoured vehicles, QEC, Thameslink, and IEP.

In order to build a substantial understanding of the projects, different sources of data were explored. These included departmental documents, reports by the National Audit Office and parliamentary select committees, debates in parliament, newspaper articles, and articles in the trade press. The research requirements of the second and third papers exploited specific sources of data from this exploration.

### **6.3 Closing remarks**

The research undertaken over the last three years makes significant contributions to knowledge. It has produced three original research articles suitable for publication in academic journals. These include the first systematic literature review on public procurement and innovation, an application of institutional theory to explain frictions in the public procurement process, and a study of public opinion towards major projects, identifying factors behind changes in opinion.

This research project explores the assumptions held about defence procurement and finds points of similarity and difference between defence and non-defence public procurement of technologically complex items. It also demonstrates novel ways of exploiting and analysing data.

A doctoral project is unlikely to be the final word on a topic. There are some limitations as well as scope for further work. Research limitations and ideas for future research are provided in each of the core research chapters, and this section may therefore include some points which have been previously mentioned.

## **Limitations**

Is defence procurement different from civilian public procurement? On the basis of this research project, the answer is ‘yes, and no’. There are some dimensions of similarity and some dimensions of differences. However, it is not certain at this point whether the degree and dimensions of similarity and difference would stay the same had the study been conducted differently. Only one civilian policy area (public transport, particularly railways) has been studied. The empirical context was further restricted to heavy manufacturing industries. Perhaps if defence procurement is compared against procurement in another civilian policy area (say public health) or for IT and software-intensive products and services, a deviation in the degree and dimensions of similarities and differences could be observed. Essentially, there is a reasonable expectation of variation in response to the research question in case the scope of the study changes.

Additionally, the procurement of trains may not be a representative case for all civilian public procurement. For example, in the study of institutional differences (Chapter 3), DfT should not be considered a ‘representative’ non-defence department. Procurement projects by the MoD may be more prone to institutional conflict than those led by the DfT, but we do not know how the MoD compares against other departments. This study does not claim a sample-to-population generalisability. The only points in this thesis where such a generalisation has been pursued relate to the extrapolation of inter-coder agreement scores (Chapters 2 to 4). At most, the procurement of trains has been used as a ‘critical case’; in other words, if defence procurement shares some similarities with the procurement of trains, can it still be claimed that defence is different? More time, data, and research will help to fill in the gaps and confirm or refute these preliminary findings.

The research framework offers the possibility of conducting a comparative study of public procurement between different sectors, beyond defence-civil comparison, as it ultimately expresses very basic tenets of similarity or difference – theory, practice, and perception. However, my research has not been able to adhere to the framework in its entirety. For example, in Chapter 3, which seeks to address the point about defence procurement in practice, what is being observed is words used by practitioners, not their actions. Words can convey intentions, but they are not the same as actions. This limits the ability of the paper to comment on the levels of actual conflict between different groups in the two fields, stopping short and commenting on the probability of conflict based on levels of institutional heterogeneity.

Among the three research papers, the most critical limitation methodologically is perhaps in Chapter 4, in the research on public opinion. In trying to capture sentiment from newspaper articles with a methodologically novel technique, I realised that a lexicon-based approach could make mistakes in interpreting the tone of a text, especially if the language was sarcastic or satirical. From Table 4.2, it is possible to note that barring one project (the aircraft carriers), the three human coders had greater agreement about the relative position of articles on a positive-negative scale between them than with the *sentimentr* package. I hope to address this in the future by investing more in developing algorithms to understand political media language.

Another limitation, noted in Chapter 5 but which may be worth repeating in the final chapter, relates to the use of secondary data in the project. The choice of data sources is dictated by research requirements and theoretical bases as well as resources like time and money. Complementing the data used in this project with primary data (interviews, ethnographic observations, surveys, experiments and workshops) may have been helpful, but it would have put me at risk of being unable to submit the PhD thesis within reasonable time.

## Directions for future research

This research generates some new questions and hypotheses and there are a number of points to be investigated further. Firstly, the systematic literature review can be a pathway for further work on public procurement and innovation. Existing research on the topic comes from different theoretical bases and uses a variety of terms. Codifying the terminology will be important for further developments in the topic. There are also several overlooked empirical contexts (non-EU, non-OECD countries in particular) and it may be useful to investigate the scope of public procurement as an innovation policy tool more universally. Most pertinently, very few studies on public procurement and innovation address questions of impact, which makes evaluating procurement as an innovation policy difficult. Given the enthusiasm for evidence-based policymaking, further research which answers questions on the potential of public procurement to fulfil innovation policy objectives will be apposite.

Another exciting direction for research lies in applying institutional theory to understand interactions and conflicts between different participants of the public procurement process. Text analysis of parliamentary committee hearings has shown differences in the vocabularies of those involved in MoD and DfT procurement projects. However, how these differences in vocabularies (and, by extension, institutional logics) translate into tensions and conflicts is not known and will necessitate collecting new data and methods, such as interviews and ethnography. There may also be the potential in extending this research into the domain of organisational studies.

Studying the institutional setting of procurement is important. Alic (2007) responds to the question of ‘why does Pentagon innovation cost so much?’ by



pointing out inter-service rivalry: there is no consensus on how to deal with security threats, with each service – Army, Navy, Air Force – giving primacy to land, sea, and air-based strategies respectively. Thus, it appears that the institutional architecture would benefit from coordination, but the procurement organisation confers great autonomy and reduces the ability to standardise and reduce costs, which makes technology procurement costly, and sometimes even redundant. Inter-service rivalry and the challenges of coordination could find echoes in a civilian department on matters of centralisation/decentralisation and collaborative purchasing. This, too, represents an avenue for comparative work.

The third paper in this thesis approaches the question of success and failure in megaproject management by using archival data to identify factors that affect public opinion over time. Usually, project management research addresses the question of critical success factors qualitatively (with case studies and interviews with stakeholders) or quantitatively (e.g. Flyvbjerg et al., 2020). It would be interesting to investigate the research question with other techniques and triangulate insights.

Methodologically, I am keen to further explore the potential of artificial intelligence and machine learning for text analysis. I am aware of researchers in computer science (Salah, 2014; Abercrombie and Batista-Navarro, 2018) working on sentiment analysis in the context of political debates and describing the problems involved in teaching machines to interpret sarcasm and humour. Collaborating with researchers from computer science and linguistics could be useful for furthering public opinion research.

Finally, I echo Gholz et al. (2018) when I say that there is very little research work on defence procurement and that more research work is needed. More pressingly, it is important for defence research to break out of the ‘military and security’ silo. This PhD provides some initial comparative work between defence and civilian public procurement. Following the successful completion of this thesis, I hope to contribute more towards creating knowledge on matters of public procurement, especially on procurement of complex product systems and megaprojects, and with luck, on defence procurement.



# Appendix A

## Additional information for Chapter 2

### A.1 Coder Manual

#### Article identifiers

Column A: Record key (assigned by first coder)

Column B: DOC ID of the article

Column C: Title of the article

Column D: Author names, separated by semicolon

Column E: Year of publication

Column F: Journal name

Column G: Subject – subject categories of journal according to the Web of Science (if not provided, please code 0)

Column H: Web of Science Research Category (if not provided, please code 0)

Column I: Web of Science Category (if not provided, please code 0)

Column J: Web of Science Keywords Plus (if not provided, please code 0)

Column K: Keywords (if there are no author/journal-provided keywords, please code 0)

Column L: Abstract (as provided in the article)

## Purpose

Column M: Research Question (Quote the author's stated research question; if there is no explicitly identified research question, please code 0.)

Column N: Type of article (**do not code 0 or leave this blank**)

Please make a choice between the following categories based on the primary contribution of the article:

1. empirical, when the primary contribution of the article is the case study and/or evaluating the practice of policy, or
2. methodological, when the article provides different approaches to address the research topic, or
3. investigative, when the article probes theory and practice to develop guidelines and framework for further research, or
4. theory-building, when the article proposes testable models and hypotheses.

Column O: Funding (Note the name of the organization that has commissioned, sponsored, or supported the research work; in case no funding is mentioned, please code 0.)

## Justifications

*An article can build upon multiple justifications.*

Column P: Buyer and user (Code 1 if the article justifies the link between public procurement and innovation by highlighting the role of the government as a user/ first-user and the importance of user-supplier interaction for innovation, 0 otherwise.)

Column Q: Market failure (Code 1 if the article justifies the link between public procurement and innovation by highlighting the ability of public procurement to generate incentives for producers and suppliers, 0 otherwise.)

Column R: Public services (Code 1 if the article justifies the link between public procurement and innovation by highlighting the provision of public services, 0 otherwise.)

## Methods

Column S: Research design (Describe the research design used in the article.)

Column T: Research method (Qualitative/Quantitative/Mixed; for an article to be quantitative, it must use numbers beyond mere description in the analysis.)

Column U: Data (Identify the type of data analyzed by the article – survey data, interviews, policy documents, etc.)

## Context

Column V: Item (Describe in author’s words what is being procured.)

Column W: Function (What function of the government is being fulfilled by the procurement? Code numbers according to the table A.1; if nothing seems appropriate, code 0. Multiple functions may be discussed by a single article.)

Table A.1: Codes for ‘Function’ (Column W)

Code	Function	Consists of
01	Defence	Military defence; civil defence; foreign military aid; R&D defence; defence affairs and administration (excluding affairs of war veterans)
02	Health	Medical products, appliances and equipment; Outpatient services; Hospital services; Public health services; R&D health; Health administration
03	Environmental protection	Waste management; waste water management; pollution abatement; protection of biodiversity and landscape; R&D environmental protection; administration of environmental protection
04	Economics-1	Agriculture, forestry, fishing and hunting; fuel and energy, mining
05	Economics-2	Construction
06	Economics-3	Transport
07	Economics-4	Communication
08	Housing and community amenities	Housing development; community development; water supply; street lighting; R&D housing and community amenities; administration of housing and community amenities
09	Public safety and social protection	Police services; fire-protection services; law courts; prisons; related R&D; administration of public order and safety; Sickness and disability; old age; survivors; family and children; unemployment; housing; social protection for socially excluded; related R&D; related administration
10	Education	Pre-primary and primary education; secondary education; post-secondary non-tertiary education; tertiary education; education not definable by level; subsidiary services to educated; related R&D; related administration

Adapted from Classification of the Functions of Government (COFOG) produced by the United Nations Statistics Division

Column X: National (Code 1 if the procurement is being done by the national government or a public organization at the national level, 0 otherwise.)

Column Y: Regional (Code 1 if the procurement is being done by the regional government or a public organization at the regional level, 0 otherwise.)

Column Z: Local (Code 1 if the procurement is being done by the local government or a public organization at the municipal level, 0 otherwise.)

Column AA: Countries (Names of countries analysed by the article. Note the name of the country even when procurement has been discussed at the regional or local level. If no countries are analyzed, code 0.)

## Findings

Column AB: Findings (Quote the main findings as the author reports them in the abstract.)

Column AC: Limitations (Quote the limitations identified by the author. This may be present at the end of the article. If no limitations are provided, please code 0.)

Column AD: Future directions (Quote the future directions suggested by the authors. If no suggestions are provided, please code 0.)

## Others

Column AE: Notes (Record any additional thoughts or considerations.)

## A.2 Corpus for systematic literature review

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# Appendix B

## Additional information for Chapter 3

### B.1 List of House of Commons select committee hearings

Table B.1: Sources of text for topic modelling

Field	Session	Title	Committee	Inclusion
defence	1999-00	Ministry of Defence: Major Projects Report 1998	Public Accounts Committee	partial
defence	1999-00	Major Procurement Projects 1999	Defence Committee	partial
defence	2000-01	Major Procurement Projects 2000	Defence Committee	partial
defence	2001-02	Major Procurement Projects 2001	Defence Committee	partial
defence	2002-03	Defence Procurement 2002	Defence Committee	partial
defence	2003-04	Defence Procurement 2003	Defence Committee	partial
defence	2003-04	Ministry of Defence: Major Projects Report 2003	Public Accounts Committee	partial
defence	2003-04	Defence Procurement 2003	Defence Committee	partial
defence	2003-04	Defence White Paper 2003	Defence Committee	partial
defence	2004-05	Future Capabilities	Defence Committee	partial
defence	2005-06	Future Carrier and Joint Combat Aircraft Programmes	Defence Committee	full
defence	2005-06	Ministry of Defence: Major Projects Report 2004	Public Accounts Committee	partial
defence	2005-06	The Defence Industrial Strategy	Defence Committee	partial
defence	2005-06	Ministry of Defence: Major Projects Report 2005	Public Accounts Committee	partial
defence	2006-07	The Army's requirement for armoured vehicles: the FRES programme	Defence Committee	full

Table B.1 continued from previous page

Field	Session	Title	Committee	Inclusion
defence	2006-07	Ministry of Defence: Major Projects Report 2006	Public Accounts Committee	partial
defence	2006-07	Defence Procurement 2006	Defence Committee	partial
defence	2007-08	Ministry of Defence: Major Projects Report 2007	Public Accounts Committee	partial
defence	2007-08	Defence Equipment 2008	Defence Committee	partial
defence	2007-08	Ministry of Defence Annual Report and Accounts 2006-07	Defence Committee	partial
defence	2008-09	Defence Equipment 2009	Defence Committee	partial
defence	2008-09	Ministry of Defence: Major Projects Report 2008	Public Accounts Committee	partial
defence	2008-09	Ministry of Defence Annual Report and Accounts 2007-08	Defence Committee	partial
defence	2009-10	Ministry of Defence: Major Projects Report 2009	Public Accounts Committee	partial
defence	2009-10	Defence Equipment 2010	Defence Committee	partial
defence	2010-12	The cost-effective delivery of an armoured vehicle capability	Public Accounts Committee	full
defence	2010-12	Providing the UK's Carrier Strike Capability	Public Accounts Committee	full
defence	2010-12	The Major Projects Report 2010	Public Accounts Committee	partial
defence	2010-12	The Strategic Defence and Security Review and the National Security Strategy	Defence Committee	partial
defence	2012-13	Ministry of Defence Annual Report and Accounts 2011-12	Defence Committee	partial
defence	2012-13	Defence Acquisition	Defence Committee	partial
defence	2013-14	Carrier Strike: the 2012 reversion decision	Public Accounts Committee	full
defence	2013-14	Ministry of Defence: Equipment Plan 2012 - 2022 and Major Projects Report 2012	Public Accounts Committee	partial
defence	2013-14	Future Army 2020	Defence Committee	partial
defence	2013-14	Ministry of Defence Annual Report and Accounts 2012-13	Defence Committee	partial
defence	2013-14	The Defence Implications of Possible Scottish Independence	Defence Committee	partial
defence	2013-14	Towards the next Defence and Security Review: Part One	Defence Committee	partial
defence	2014-15	Decision-making in Defence Policy	Defence Committee	partial
defence	2014-15	Re-thinking defence to meet new threats	Defence Committee	partial
defence	2016-17	The Defence Equipment Plan 2016	Public Accounts Committee	partial
defence	2016-17	SDSR 2015 and the Army	Defence Committee	partial

Table B.1 continued from previous page

Field	Session	Title	Committee	Inclusion
defence	2017-19	Delivering Carrier Strike	Public Accounts Committee	full
transport	2000-01	Strategic Rail Authority: Action to Improve Passenger Rail Services	Public Accounts Committee	partial
transport	2000-01	Rail investment: renewal, maintenance and development of the national rail network	Transport Committee	partial
transport	2002-03	Overcrowding on Public Transport	Transport Committee	partial
transport	2003-04	Future of the Railway	Transport Committee	partial
transport	2004-05	Network Rail: making a fresh start	Public Accounts Committee	partial
transport	2007-08	Delivering a sustainable railway: a 30-year strategy for the railways?	Transport Committee	partial
transport	2008-09	Rail fares and franchises	Transport Committee	partial
transport	2009-10	The performance of the Department for Transport	Transport Committee	partial
transport	2010-12	Thameslink rolling stock procurement	Transport Committee	full
transport	2010-12	Department for Transport: The InterCity East Coast Passenger Rail Franchise	Public Accounts Committee	partial
transport	2013-14	Progress in delivering the Thameslink programme	Public Accounts Committee	full
transport	2014-15	Procuring new trains	Public Accounts Committee	full
transport	2014-15	Lessons from major rail infrastructure programmes	Public Accounts Committee	partial
transport	2015-16	Reform of the rail franchising programme	Public Accounts Committee	partial
transport	2016-17	Modernising the Great Western Railway	Public Accounts Committee	full
transport	2016-17	Rail franchising	Transport Committee	partial
transport	2016-17	The future of rail: Improving the rail passenger experience	Transport Committee	partial
transport	2017-19	Update on the Thameslink Programme	Public Accounts Committee	full
transport	2017-19	Rail franchising in the UK	Public Accounts Committee	partial
transport	2017-19	Rail timetable changes: May 2018	Transport Committee	partial

## B.2 Custom stopwords

### Defence stopwords

admiral	does	gets	look	said	sometime	thing	want
air	done	give	lord	saw	sometimes	things	wanted
aircraft	dont	given	marshal	say	somewhere	think	wanting
also	don't	gives	minister	see	speak	thinks	wants
although	eight	got	much	seek	speaks	third	was
another	elizabeth	hand	nick	seeks	still	though	way
anything	else	hear	no	seem	stuff	three	ways
are	elsewhere	heard	one	seems	sure	throughout	welcome
brennan	even	hears	otherwise	seen	take	told	welcomes
came	feel	held	page	sees	taken	true	went
can	feels	hms	pages	seven	talk	two	whatever
carrier	felt	is	paper	shall	talked	unless	whether
carriers	find	jackson	paragraph	sir	talking	upon	whilst
chair	finds	kevin	per	sit	talks	various	will
chairman	five	kingdom	perhaps	six	tell	vehicle	wish
chief	found	lambert	peter	somebody	tells	vehicles	write
come	four	led	point	someone	thank	vice	written
coward	general	let	programme	something	thanks	view	yes
document	get	lieutenant	queen	somethings	therefore	views	

### Transport stopwords

across	don't	hear	looks	said	speaks	thinks	wanting
already	eight	heard	lord	saw	still	third	wants
also	either	hears	made	say	stock	though	was
although	else	held	make	see	stuff	three	way
another	elsewhere	hurn	makes	seek	sure	throughout	ways
anything	even	iep	member	seeks	take	told	welcome
are	everything	is	minister	seem	take	took	welcomes
around	feel	just	much	seems	taken	train	went
bit	feels	keep	no	seen	taken	trains	whatever
bristol	felt	keeper	one	sees	takes	tried	whether
came	find	keeping	otherwise	seven	talk	tries	whilst
can	finds	kept	page	shall	talked	true	will
chadwick	first	kingdom	pages	sir	talking	try	wish
chair	five	know	paper	sit	talks	trying	within
chairman	found	known	paragraph	six	tell	two	without
chief	four	knows	per	somebody	tells	united	write
come	get	led	perhaps	someone	thameslink	unless	written
crossrail	gets	let	point	something	thank	upon	yes
department	give	london	programme	somethings	thanks	various	
document	given	look	rail	sometime	therefore	view	
does	gives	look	railway	sometimes	thing	views	
done	got	looked	rolling	somewhere	things	want	
dont	hand	looking	rutnam	speak	think	wanted	



## B.3 Topic distribution data

Table B.2: Topic distribution across different groups (defence)

spk_cat	n	Topic 1	Topic 2	Topic 3	Topic 4
mp	710	76	34	21	579
cs_mod (mod)	459	101	34	34	290
military (mod)	386	10	99	40	237
min_mod (mod)	196	50	9	9	128
industry	123	42	15	1	65
mod	45	27	15	3	0
nao	22	2	0	2	18
academic	15	0	5	0	10
thinktank	7	1	4	0	2
consultant	3	2	1	0	0
union	2	0	2	0	0
cs_co	2	0	0	0	2
other	2	0	0	2	0
min_pm	1	0	0	0	1
hmt	1	0	0	0	1
journalist	1	0	0	0	1
scot_msp	1	0	0	0	1

Table B.3: Topic distribution across different groups (transport)

spk_cat	n	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6
mp	445	37	19	28	172	111	78
cs_dft (dft)	487	21	23	28	104	202	109
industry	128	37	10	3	20	17	41
min_dft (dft)	43	23	2	4	2	5	7
nao	18	0	0	1	4	10	3
eu	12	0	0	7	5	0	0
academic	13	2	0	9	2	0	0
advocacy	10	0	1	2	0	0	7
union	10	6	0	0	2	0	2
users	9	0	0	0	2	1	6
dft	6	1	0	1	0	1	3
council	3	1	0	0	1	0	1
consultant	1	0	0	0	1	0	0
journalist	1	0	0	0	0	0	1
tfl	1	0	0	0	0	0	1



# Appendix C

## Additional information for Chapter 4

### C.1 Selection criteria for Table 4.3

In order to select periods as ‘good’ or ‘high’ public opinion (and conversely ‘bad’ or ‘low’ public opinion), the following thresholds were used:

Table C.1: Criteria for selecting months

<b>For a month to be included in analysis:</b>	<b>Queen Elizabeth programme</b>	<b>Armoured Cavalry 2025</b>	<b>Thameslink programme</b>	<b>Intercity Express Programme</b>
Average sentiment score is above the upper quartile, or	0.108	0.114	0.077	0.172
Average sentiment score is below the lower quartile, and	0.029	-0.025	-0.025	0.048
Number of articles is at least ...	12	3	8	5

Based on the selection criteria in Table C.1, the following number of months and articles were analysed for their content for each project:

Table C.2: Details of content analysed for Table 4.3

	<b>Queen Elizabeth programme</b>	<b>Armoured Cavalry 2025</b>	<b>Thameslink programme</b>	<b>Intercity Express Programme</b>
<b>No. of months with high public opinion</b>	21	20	6	10
<b>Total articles</b>	615	80	61	107
<b>No. of months with low public opinion</b>	20	32	15	10
<b>Total articles</b>	541	159	241	77

## C.2 Selection criteria for Table 4.5

Table C.3: Criteria for selecting turning points

	<b>QEC</b>	<b>Ajax</b>	<b>TP</b>	<b>IEP</b>
No. of times cusum rises	44	49	33	36
No. of times cusum falls	44	49	33	35
Min. no. of articles between turning points to qualify for analysis	48	9	32	20
Turning points analysed (rise)	9	7	1	8
Avg no. of articles between turning points	96.7	11.42	51	35.125
Turning points analysed (fall)	11	11	5	6
Avg no. of articles between turning points	99.9	21.45	143.2	39.67

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