Regional and Business Studies (2022) Vol 14 No 1, 33-55
Hungarian University of Agriculture and Life Sciences Kaposvár Campus
Kaposvár
doi: 10.33568/rbs.3302

DEFENCE ACQUISITION: A WICKED PROBLEM?

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ABSTRACT

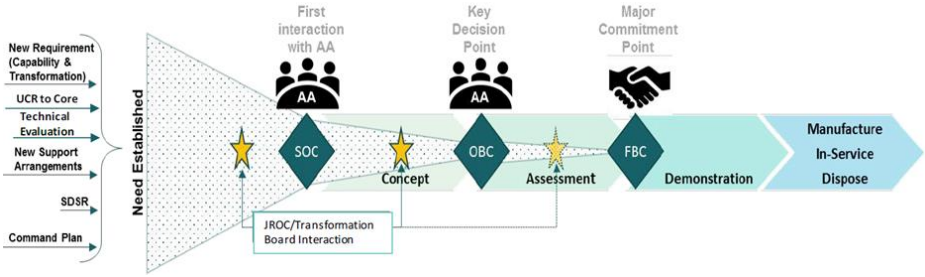
Defence acquisition is a complex undertaking involving multiple actors and processes. However, in recent years, the US and UK defence acquisition frameworks have been criticised for not being able to cope with the complex and uncertain nature of defence. The paper takes this criticism and argues that defence acquisition is best understood as a "wicked problem" in which collective processes tie the system into large and interconnected networks of systems, not as a traditional linear science problem. In particular, the paper demonstrates that the Linear Transformation Model, at the heart of the US and UK defence acquisition framework, is ill-designed to cope with the complex and uncertain nature of both defence outputs and outcomes. The main reasons are technological maturity, information asymmetry and the need for interpretation and judgement. Furthermore, the paper elaborates that defence acquisition is characterised by a "problem of theory" and a "problem of practice" and that further research is necessary in order to transform its institutional culture and tackle the theory-practice divide with a more holistic approach.
Keywords: linear transformation model, second generation systems approach, theory-practice divide, advanced weapon systems

INTRODUCTION

"Acquisition is how we work together with industry to provide the necessary military capability to meet the needs of our Armed Forces now and in the future. It covers the setting of requirements; the selection, development and manufacture of a solution to meet those requirements; the introduction into service and support of equipment or other elements of capability through life, and its appropriate disposal." (*MOD*, 2022)

The above quote from the *UK Ministry of Defence* (MOD) suggests that defence acquisition is a complex undertaking involving multiple actors and processes. Indeed, by contrast to procurement, which refers to a single (and simple) public activity of contracting with a provider to buy a good or a service, acquisition describes a complete cycle with different phases, milestones and key decision points (*Lefeez*, 2017a). For example, the UK Smart Acquisition Framework identifies six phases (Concept, Assessment, Demonstration, Manufacture, In-Service and Disposal), and three key approval points: Strategic Outline Case (SOC), Outline Business Case (OBC) and Full Business Case (FBC) (*Figure 1*).

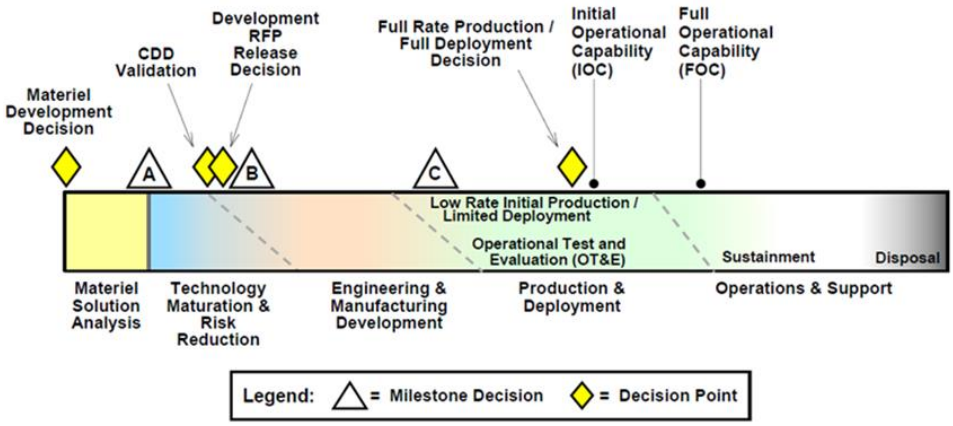
Figure 1: UK's Defence Acquisition Framework: CADMID



Source: *MOD*, 2022, p. 14

The US Major Capability Acquisition Model identifies five phases (Material Solution Analysis, Technology Maturation and Risk Reduction, Engineering and Manufacturing Development, Production and Deployment, and Operations and Support), there milestone decisions (Milestone Decisions A, B and C) and four critical decision points (Material Development Decision, CCD Validation, Development RFP Release Decision and Full Rate Production/Full Deployment Decision) (*Figure 2*).

Figure 2: The US Major Capability Acquisition Model



Source: *DOD* (2021, p. 10)

However, in recent years, the US and UK frameworks have been criticised for not being able to cope with the complex and uncertain nature of defence and defence acquisition (see *Rendon & Snider*, 2019; *Burgess & Antill*, 2017). The paper takes up this criticism and argues that defence acquisition is best understood as a "wicked problem" (*Rittel & Webber*, 1973) and not as a "linear science problem" as suggested by the US and UK frameworks. The difference is crucial. While traditional science problems can be dissected into smaller, segregated (bounded) systems and addressed by a cybernetic cycle of governance as in *Deming's* (1984) plan-do-check-act framework, in wicked problems, the collective processes tie the systems into large

and interconnected networks of systems, such that outputs from one system become inputs to another system (*Rittel & Webber*, 1973, p. 159). It is therefore less apparent where the centre of the problem lies and where and how to intervene. *Rittel & Webber* (1973) defined ten distinguishing properties of wicked problems (*Table 1*).

Table 1: The ten properties of wicked problems

Nr	Property
1	There is no definitive formulation of a wicked problem.
2	Wicked problems do not have an exhaustive describable set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
3	Every wicked problem can be considered to be a symptom of another problem.
4	The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The chosen explanation determines the nature of the problem‘s resolution.
5	Wicked problems have no stopping rule.
6	Solutions to wicked problems are not true-or-false, but good-or-bad
7	Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
8	The planner has no right to be wrong.
9	There is no immediate and no ultimate test of a solution to a wicked problem.
10	Every wicked problem is essentially unique.

Source: Based on *Rittel & Webber* (1973)

LITERATURE REVIEW

As indicated in the introduction, defence acquisition is plagued by various challenges. The literature review discusses these challenges. One of the primary issues in defence acquisition is the high costs of military equipment and services. According to *Smith* (2022) and *Hartley* (2020a), cost overruns are common in defence acquisition programmes and frequently result in delayed delivery and reduced performance. The authors identify (technological) uncertainty and the dominance of government as a monopsony customer precluding a market in weapons as key factors. However, the authors also deplore the scarcity and unavailability of reliable data (*Hartley*, 2020a, p. 72). Tackling this data shortage gap, *Etemadi* (2020) examined major defence acquisition programmes (MDAPs) in the US from 2007 to 2018 and found that on average, it takes the *Department of Defense* (DOD) about eight years to deliver a new system (or new capabilities) to the operating forces using existing acquisition processes. His study attributes delays and cost overruns to multiple factors, including the adaptation of user requirements, the pace of technology and adversary change, and inefficient management practices. Similarly to *Etemadi* (2020), *Jones* (2022) also reviewed US MDAPs and identified a statistically significant difference between the Cost Growth Factors (CGFs) between the 1990s and the 2010s, with the 2010s exhibiting lower CGFs than the 1990s. She explains this variance by different reform cycles, where the reforms of the 2010s era, which focus on restricting Acquisition,

Technology and Logistics, proved more efficient than the reforms of the 1990s era, which aims to mandate for Change and Transformation.

Jones's (2022) research findings are backed by *Ahner et al.* (2019), who demonstrate that the *DOD* has significantly improved its decision-making culture by introducing the scientific test and analysis techniques (STAT) in its test and evaluation (T&E) process in 2012. Following the authors, STAT has become a key element, not only for generating the knowledge to mature existing technologies that fulfil a requirement gap (e.g. F-35 combat aircraft) and to inform on the performance of new technologies (e.g. autonomous systems), but also for lowering the costs of MDAPs (*Ahner et al.*, 2019).

In a similar vein, the 2022 and 2021 Annual Assessment reports by the *Government Accountability Office* (GAO) identified cost overruns as significant challenges in defence acquisition. The reports found that the DOD has experienced cost overruns in several key programmes, including the F-35 combat aircraft, the Ford-class aircraft carrier (i.e. CVN-78) and the Zumwalt-class destroyer. Among others, the report urges the DOD to improve its cost estimation processes and to use more accurate data for assessing the financial impacts of its MDAPs (*GAO*, 2022; *GAO*, 2021). A 2022 report by the RAND Corporation confirms the criticism expressed by GAO and underscores that there is no one-size-fits-all approach that works with every defence acquisition programme (*Wong et al.*, 2022). The report highlights that attempts to force programmes into a single paradigm lead to problems and inefficiencies. The authors recommend tailoring acquisition strategies, organizational roles and responsibilities and reporting structures to the unique characteristics of each programme (*Wong et al.*, 2022).

However, cost overruns can also result from unforeseen events such as the COVID-19 pandemic. The pandemic has disrupted global supply chains and impacted the delivery of equipment and services, leading to cost increases and schedule delays in many sectors, including defence (*Panwar et al.*, 2022; *Lopes Pimenta et al.*, 2022). The fiscal year (FY) 2020 Annual Report from the *Director Operational Test and Evaluation* (DOT&E) highlights that the changes DOT&E services and agencies instituted in response to the pandemic affected T&E for one-third of the programmes under its oversight (i.e. 75 programmes) (*DOT&E*, 2021). Action officers participated only in events deemed mission-essential such as live fire and operational tests for the F-35 and CVN-78 programmes. Likewise, a report commissioned by the European Parliament in 2021 points out that the COVID-19 pandemic has accentuated already recognised capacity shortfalls of the EU Common Security and Defence Policy (CSDP), including strategic airlift, secure communications and command and control (*Meyer et al.*, 2021).

A further area of concern in defence acquisition is the lengthy procurement process, which refers to the delays and other obstacles that can arise during the process due to complex regulations, procedures, and organisational hierarchies (*Šumpíková & Ďurčeková*, 2019). A 2021 defence efficiency report from the *National Audit Office* (NAO) notes that the UK MOD and its suppliers have both contributed to schedule delays across the contracted programmes that it investigated, resulting in shortfalls in the defence capability of the UK Armed Forces (*Davies*, 2021). NAO highlights that overall, the MOD faces cumulative forecast net delays to equipment

entering into service of 254 months across 13 programmes. Importantly, NAO sees that the causes for delays are multi-factorial, ranging from over-optimistic schedules and supplier performance to contract management and departmental austerity measures (*Davies*, 2021).

By contrast to NAO, *van Weele & Essig* (2017) trace a lengthy procurement process back to complex procurement regulation, most notably the EU Defence Procurement Directive 2009/81/EC, and stress that the public sector lacks a professional procurement system and adequate specialists. In particular, the authors emphasise that whilst EU procurement regulations make a lot of sense in their own right, many EU governments are simply unable to implement them in a meaningful way and make extensive use of exceptions such as Article 346 of the Treaty on the Functioning of the European Union, allowing a member state to divert from EU procurement regulation in order to protect their essential security interests (*van Weele & Essig*, 2017).

Closely connected to the procurement process issue is the question of transparency, as a lack of transparency can lead to corruption, mismanagement and inefficient allocation of resources. In his review of the Belgian defence acquisition system, *Reykers* (2021) shows that parliamentary oversight can help prevent corruption, reduce wasteful spending and ensure that defence procurement meets the needs of the military end-users. One of the key lessons from the Belgian experience is the importance of early engagement by parliament in the defence acquisition process. The Belgian parliament, via its Defence Committee, is involved in the planning and development stages of military procurement projects, which allows the committee to provide feedback and make recommendations to the government. This early engagement can help ensure that defence programmes are aligned with the strategic and operational needs of the military and that potential issues are addressed early on. The committee furthermore provides valuable inputs to the government, which publishes an annual report on defence acquisition, containing information on the contracts awarded to the defence industry (e.g. value, nature of the system, and others) (*Reykers*, 2021).

Another challenge in defence acquisition is the lack of consistency in procurement data and reporting. A 2021 NAO report highlights that the UK MOD lacks accurate information on the progress of some programmes, which in turn makes it difficult to monitor suppliers' performance (*Davies*, 2021). This criticism is echoed by the 2022 and 2021 GAO Annual Assessment reports (*GAO*, 2022; *GAO* 2021). However, NAO acknowledges that the MOD has taken steps to address the procurement data and reporting issue, for example by introducing earlier support and scrutiny to programmes in order to identify gaps in knowledge and by applying *Earned Value Management* (EVM) techniques to measure supplier progress more accurately (e.g. Crowsnest radar system) (*Davies*, 2021).

The reports by NAO and GAO are in line with the recent academic literature on the governance of the principal and agent relationship, which emphasises the need for formal control and coordination mechanisms, including penalties and incentive schemes (see *Aben et al.* 2021; *van Strien et al.*, 2019. However, these studies also highlight that a contractual approach on its own is not sufficient for managing the buyer-supplier relationship and needs to be complemented by relational factors such as trust, open communication and the co-creation of value. In fact, the studies

confirm the need for a "third way" in defence acquisition; a way that lies between the cost-plus contracts of the post-World War II era and the fixed price contracts of the post-Cold War era (*Wylie*, 2017; *Roehrich et al.*, 2014; *Caldwell & Howard*, 2011; *Markowski et al.,* 2010; *Lewis & Roehrich*, 2009).

Some countries such as the UK show sign of embarking on such a "third way" trajectory. Following the 2021 Defence and Security Industrial Strategy (DSIS), the UK is taking a more protective industrial stance in the future and is doing away with its competition by default policy (*MOD*, 2021). DSIS cites the UK's departure from the EU as an opportunity to reform its Defence and Security Public Contracts Regulations that were devised in 2011 in compliance with EU Defence Procurement Directive 2009/81/EC. The new strategy seeks to provide strong support for defence exports through increased clarity on programme requirements and the use of a new government-to-government commercial mechanism, with the US being a key strategic partner here (*McGerty*, 2021).

A further concern in defence acquisition is the consolidation of the defence sector. Today, the defence sector is dominated by only a few firsttier giants operating as system integrators and hosts of second and thirdtier suppliers supporting the activities of these giants (*Tian*, 2020; *Fonfría & Sempere*, 2020). On the US side, these defence giants are Lockheed Martin, Northrop Grumman, Raytheon, Boeing and General Dynamics. On the European side, the defence giants are BAE Systems, Airbus, Thales and Leonardo (*SIPRI*, 2022). A 2022 report from the Office of the *Under Secretary of Defense for Acquisition and Sustainment* (USDA&S) considers competition within the defence industrial base vital, arguing that competition incentivizes innovation by driving the industry to offer its best technical solutions at a best-value cost and price (*USDA*&*S*, 2022). However, the report deplores that since the 1990s, the defence sector has consolidated substantially, transitioning from 51 to 5 aerospace and defence prime contractors. Most importantly, the report assesses this as a significant national security risk, most notably because a dominant supplier can easily be influenced by an adversary nation (*USDA*&*S*, 2022).

Another issue in defence acquisition is the ongoing use of immature technologies. A 2020 GAO study identifies a low technology readiness level (TRL) as an important driver of rising unit costs and lead-time overrun (*GAO*, 2020a). The study demonstrates that MDAPs with a low TRL have suffered from important cost growth and schedule delays, whereas MDAPs with a high technology TRL have stayed within their initial budget and time boundaries (*Table 2*). This criticism is not new, however. For example, *Bailey et al.* (2014) deplore that in spite of the rising evidence that programmes with immature technology experience cost, schedule, and performance shortfalls, US military services (e.g. Army, Navy and Air Force) exhibit a strong tendency to ignore this fact (*Bailey et al.*, 2014). Similarly, *Pennock* (2015, 2008) underscores that despite changes in the acquisition regulations to encourage a more evolutionary approach to systems development (e.g. STAT), which require the use of more mature technologies, MDAPs continued to rely on immature technologies. *Pennock* (2015, 2008) traces this behaviour back to a tragedy of the commons in which the different US military services (e.g. Army, Navy and Air Force) are overexploiting the commons (here: MDAPs); the reason being that there is no cost for them to do so.

Table 2: US Cost and Schedule Experiences for Products with Mature and Immature Technologies

Product development			
Product development and associated technologies	**TRL at program initiation**	**Cost growth**	**Schedule delay**
Comanche helicopter		101 percent	120 percent
- Engine	5		
- Rotor	5		
- Forward-looking infrared	3		
- Helmet-mounted display	3		
- Integrated avionics	3		
Brilliant anti-armor submunition		88 percent	62 percent
- Acoustic sensor	2		
- Infrared seeker	3		
- Warhead	3		
- Inertial measurement unit	3		
- Data processors	3		
Hughes HS-702 satellite		None	None
- Solar cell array	6		
Ford Jaguar automobile		None	None
- Adaptive cruise control	8		
- Voice-activated controls	8		

Source: Based on *GAO*, 2020a, p. 27

Finally, a last constraint in defence acquisition is the importance of national security interests, which has negatively impacted international collaborative acquisition programmes. For example, *Calcara* (2018) investigated four European collaborative aircraft programmes (NH90, A400M, Eurofighter and Tornado) and concluded that in each instance, relative gains considerations were crucial to explaining a member nation's preference towards cooperation. Most importantly, *Calcara* (2018, p. 493) stresses that 'in spite of the potential absolute gains in pursuing joint initiatives in the defence-industrial landscape', European governments and industries are hesitant in sharing defence technologies which have been developed with national resources and they need to consider how technology transfer could strengthen rivals' position in the regional and global market'.

Calcara's (2018) findings are supported by *Kanniainen & Lehtonen* (2020), who, by drawing on a game theory model, identify four reasons why collaborative defence acquisition is more of an exception in NATO and the EU than the rule: First, key user requirements are nation-specific with important implications for national security. Second, nations that place a low value on a weapon system have more bargaining power than nations that place a high value on a weapon system and may require a side payment to enter a procurement collaboration that the other side is not willing to pay. Third, the potential gains from cooperative procurement, namely economies of scale and increased knowledge and technology transfer, may not be sufficient to compensate for

conflicting key user requirements. Fourth, short-term optimism tends to prevail over long-term commitment (*Kanniainen & Lehtonen*, 2020, p. 201).

METHODOLOGY

Building on the insight gained from the literature review and on insights from his own research on no-capability defence acquisition (see *Verlaine,* 2022a; 2022b; in press-a, in press-b), the author assumes that the following eight properties of *Rittel & Webber's* (1973) wicked problems also have relevance in defence acquisition:

(1) There is no definitive formulation of a wicked problem.
(2) Wicked problems do not have an exhaustively describable set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
(3) Every wicked problem can be considered to be a symptom of another problem.
(4) The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The chosen explanation determines the nature of the problem‘s resolution.
(5) Wicked problems have no stopping rule.
(6) Solutions to wicked problems are not true-or-false, but good-or-bad
(7) Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
(8) The planner has no right to be wrong.

The author investigates each of these properties separately through the lens of a second-generation systems approach (that is an approach which accounts for the networked structure and collective workings in defence acquisition) and tests them against their explanatory power and empirical validity. The analysis is informed by political, economic and management theory and classical concepts such as institutional logic (*Friedland & Alford*, 1991), experiential learning (*Kolb*, 1984), competitive advantage (*Porter*, 1985), dynamic capabilities (*Teece et al.*, 1997), and organisational ambidexterity (*O'Reilly & Tushman*, 2013).

ANALYSIS AND DISCUSSION

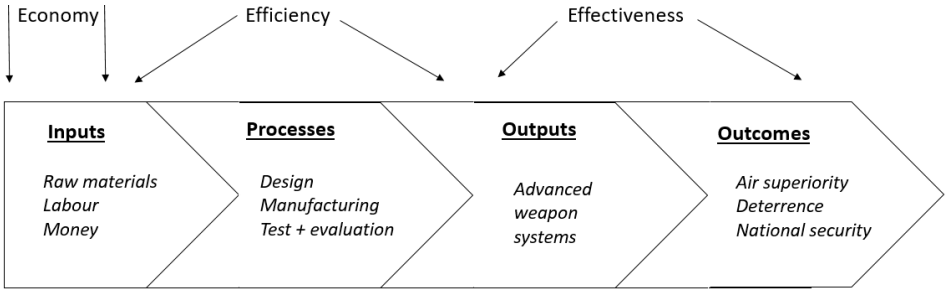
There is no definitive formulation of a wicked problem

Following *Rittel & Webber* (1973, p. 161), the information needed to understand a wicked problem depends upon one's ideas for solving it. Moreover, in order to describe the problem in sufficient detail, one has to develop an exhaustive inventory of all conceivable solutions ahead of time. The dilemma however is that in order to anticipate all questions, knowledge of all conceivable solutions is required. The US and UK defence acquisition frameworks presuppose such knowledge. In fact, they follow a linear transformation logic in which inputs are converted through processes into outputs and outcomes (*Figure 3*).

Especially with the introduction of the neoliberal reform agenda and its efficiency policies (i.e. New Public Management), the Linear Transformation Model has gained

popularity, not least because of its promise to deliver greater value-for-money, where value-for-money is defined as the ratio between economy (spending less on inputs), efficiency (output relative to the input) and effectiveness (a measure of the impact achieved) (*Wylie*, 2017, p. 168). However, the overall success of the Linear Transformation Model is mixed.

Figure 3: The Linear Transformation Model



Source: Redrawn from *Louth* (2010, p. 108)

Indeed, in a comparative study of cost and performance changes between the UK and US major defence acquisition programmes based on government audit data from 2013 and 2014, *Bellais & Droff* (2017) conclude that despite the implementation of successive defence acquisition reforms (e.g. Smart Acquisition in the UK and Adaptive Acquisition in the US), there has been no perceptible change since the 1990s and defence programmes are still sensible to under-performances and delays. This trend is confirmed by a 2020 GAO report on defence acquisitions which highlights that major defence acquisition programmes have accumulated over $628 billion (or 54 per cent) in total cost growth since the program started and that over the same time period, the time required to deliver initial capabilities has increased by 30 per cent, resulting in an average delay of more than two years (*GAO*, 2020b, p. 2).

The problem is that the Linear Transformation Model draws on a simple cause-effect rationale which does not take into account the wider contextual factors inherent to defence acquisition. It is essentially based on a one-dimensional approach in which a desired outcome (e.g. national security) determines the requirements for the outputs (e.g. tanks, aircraft, missiles) which in turn determine the requirements for inputs (e.g. raw materials, manpower) and processes (e.g. design, R&D, manufacturing). As such, it is unable to address more complex questions such as the desirability of one weapon system over another or the value of national security.

In terms of the former, key technologies which are at the heart of major platform systems (e.g. combat aircraft, battleships and tanks) have reached their maturity and incremental performance improvements come with complex solutions, technological uncertainties and rising challenges during the development stage (*Davies et al.*, 2012). The F-35 combat aircraft provides a good example of how the choice of a defence output (in this case a fifth-generation combat aircraft) which is supportive of a certain outcome (in this case air superiority) has become a hot subject of debate, not least because of its cost and schedule escalation (*CRS*, 2022; *Petrelli*, 2020).

With respect to the latter, national security, it is worth recalling that national security is generally considered a public good. As such, it carries not only military value but also significant social value, particularly in relation to its opportunity cost, that is the value given up by engaging means into defence, relative to engaging them in health or education (*Markowski et al., 2010*, p. 14). The point is that national security leaves significant room for interpretation.

Overall, the military and social value of defence outcomes and their uncertain nature make it difficult to work out the derived demand for defence inputs and the associated industry capabilities.

Wicked problems do not have an exhaustively describable set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan

Moreover, defence outcomes comprise two subsets, one related to deterrence and the other related to the actual deployment of force (*Markowski et al.*, 2010, p.15). It is the latter that is the most problematic as it implies being prepared for multiple and unforeseeable military contingencies or threat scenarios. For example, from the Cold War to the Russo-Ukrainian War, the risk of state-on-state conflict had diminished, whilst the likelihood of conflict involving non-state and failed state actors employing asymmetric tactics such as economic, cyber and proxy actions rather than direct military confrontation had increased (*Bishop*, 2017, p. 58).

In order to respond to potential threat scenarios, the defence must generate appropriate military capabilities (outputs). Knowing what military capabilities are required calls not only for knowledge of a wide range of scenarios but also for informed judgement and decision-making. Indeed, similarly to *Rittel & Webber's* (1973, p. 164) planning-type problems, in which a host of potential solutions arises and in which "the set of feasible plans of action" relies on realistic judgement, the capability to apprise exotic ideas and on the amount of trust and credibility between planner and clientele", in defence acquisition, "the set of a feasible plan of action" requires balancing the likelihood of the threat, the impact of the desired outcome, the effect of the planned output and the costs of the engaged inputs and process.

The difficulty however is that decisions need to be taken on the basis of imperfect information and are thus doomed to interpretation and value judgment. The lack of (reliable) information and data is a result of how the defence is organised and managed in practice: Since only a few threat scenarios will ever materialise, what states actually provide through defence acquisition is a contingent capability, that is a capability that has the potential to be used if certain contingencies occur, but which will otherwise be visible only in the context of exercises and simulations (*Markowski et al.*, 2010, p. 17). On a positive note, exercises and simulations have the potential to enhance learning about how military assets perform in controlled experiments. On the negative side though, exercise and simulations lack the true dynamics of the real battlefield with their informational asymmetries and rapid product and process innovation by the combatants. In brief, contingent military capabilities cannot be directly measured in peacetime and rely on interpretation and judgment (*Markowski et al.*, 2010, p. 17).

Every wicked problem can be considered to be a symptom of another problem

A further difficulty in decision-making in defence acquisition stems from the unequal distribution of information between the buyer and the seller (*Hartley and Belin*, 2020). This is particularly relevant in the context of innovation and new technologies, in which military suppliers tend to have a competitive advantage (*Porter*, 1985) over their buyers (nation-states). In order to better understand this situation, a look into defence acquisition history and its evolution since World War II is necessary.

Over many decades, states have been focused on leading technology development and many technological and material innovations have come from defence R&D and have subsequently been commercialised for general application (*Neal*, 2017, p. 160). However, this is no longer the case. With the introduction of the global neoliberal agenda and the subsequent application of the New Public Management framework to defence acquisition, many hitherto state-owned military tasks and services have been outsourced and privatised (*Ekström & Dorn*, 2014). Today, the prime sources of innovation come from the commercial sector and increasingly states look to industry for possible technologies and materials that they can utilise. To add a further layer of difficulty, the majority of new products and innovative solutions do not come from large defence companies but rather from the defence sector small to medium size enterprises (SMEs) or indeed from non-defence industries (*Hartley*, 2018, *Neal,* 2017).

The point is that knowledge and know-how are no longer state-owned but contained within different professional networks and organisational cultures. Following *McAvoy* (2017, p. 223), state actors need to liberate themselves from their embedded interpretations of social reality and their dominant institutional logics (e.g. mind-sets like "the way things are done around here") in order to harvest and decode the new forms of knowledge and know-how. The reason is that institutional logic is endemic to a particular institutional order and involves an agent's interpretation of social reality within the environmental context in which the institutional logic is translated (*Friedland & Alford*, 1991).

From such a perspective, the neoliberal policy reforms of defence acquisition (i.e. competition as the default mechanism and risk transfer to the private sector) only address a symptom of the problem (i.e. escalating costs of modern weapon systems and shrinking defence budgets) and not its root cause: an obsolete institutional culture that needs to develop new skill sets and competencies to match the changing environment of defence acquisition. In *Moore's* (2017, p. 256) words: "In order to successfully assimilate and integrate all of the complexities and complications of the defence acquisition context, those involved must respond to stimuli from inside and outside of the defence acquisition environment."

While for *Moore* (2017, p. 256), the development of an own body of knowledge through practice and experiential learning (*Kolb*, 1984) is at the centre of the problem, for others, the lack of practical knowledge is only a symptom of a higher problem, namely the lack of a theoretical knowledge base. For example, *Burgess* (2017, p. 2) argues that defence acquisition should have not only a unique body of knowledge, but also its own distinct theory and that a combination of practical know-how and theoretical know-why should be applied. For him, Western neoliberal reform agendas

have fundamentally altered the roles, systems and processes of defence acquisition, so that a far more comprehensive theory is required to effectively inform current and future practice requirements (*Burgess*, 2017, p. 2).

The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution

The theory-practice divide in defence acquisition confirms *Rittel & Webber's* (1973, p. 165) point that "the level at which a [wicked] problem is selected depends upon the self-confidence of the analyst and cannot be decided on logical grounds" and that "the higher the level of a [wicked] problem's formulation, the broader and more general it becomes and the more difficult it becomes to do something about it". Most importantly, it illustrates that the analyst's worldview is the strongest determining factor in explaining a discrepancy, and thus resolving a wicked problem (*Rittel & Webber's*, 1973, p. 166).

In *Moore's* (2017) worldview, decision-making in defence acquisition should be informed by professional judgement based on a balanced mix of professional, contextual and specialised knowledge. In particular, *Moore* (2017, p. 255) advocates a novel defence acquisition professionalism that builds on "wider, outside-the-box thinking, intuition, flair, innovation, diplomacy, the ability to work within a team to solve practical problems and above all to exercise judgement to gain optimum solutions for all stakeholders". *Moore's* (2017) position is backed by *Leefez* (2017a) who lobbies for a multi-theoretical perspective to investigate defence acquisition practices. For *Lefeez* (2017a, p. 80), a narrow-based approach to management is reductive because defence acquisition is more than a matter of efficient allocation of resources and thus begs for a broad-based approach capable of including the social context in which defence acquisition programmes take place.

Wicked problems have no stopping rule

By contrast to solving a traditional science problem (e.g. mathematical equation), where it is easy to tell if and when the job has been done, solving a defence acquisition problem is not as clear cut. Although the Linear Transformation Model might suggest so (*Figure 3*), the preceding discussion has shown otherwise. Indeed, because threat scenarios are inherently contingent, their solutions (advanced weapon systems) are also contingent. This adds an important layer of uncertainty to defence acquisition: A state can never be too confident that its military capabilities are able to cover the next threat scenario, the reason being that the nature of actual and potential warfare continuously changes as a result of technological change and new developments in strategic thinking (*Markowski et al.*, 2010, p. 29). For example, in the Afghanistan and Iraq Wars, the US ground forces faced irregular warfare scenarios to which they were ill-prepared. Their vehicles were vulnerable to mine and improvised explosive device (IED) attacks and needed to be retrofitted with a mine-resistant ambush protection (MRAP) kit (*Feickert*, 2011). Since then, MRAP has become an important user requirement and is integrated into many vehicles from scratch.

In spite of the proliferation of irregular warfare scenarios (e.g. Mali, Democratic Republic of Congo), the recent Russian attack on Ukraine is a powerful reminder that the threat of interstate war (i.e. conventional warfare) cannot be ignored. Hence, states need dynamic capabilities (*Teece et al.*, 1997) to integrate, build, and reconfigure internal as well as external competencies to address the rapidly changing security environment (*Balakrishnan*, 2017, p. 274). In management theory, the ability to prepare for the "old" and "new" is known as organisational ambidexterity. *O'Reilly & Tushman* (*2013*, p. 324) define organisational ambidexterity as "the ability of an organisation to both explore and exploit" where exploiting refers to "competing in mature technologies and markets in which efficiency, control, and incremental improvements are prized", and exploring refers to "competing in new technologies and markets in which flexibility, autonomy, and experimentation is needed". Most importantly, *O'Reilly & Tushman* (2013, p. 324) see long-term firm survival as dependent on the ability to simultaneously pursue incremental and discontinuous innovation.

The arguments put forward by *O'Reilly & Tushman* (2013) hold true for defence and defence acquisition. In order to cover old and new security threats, states need to improve existing capabilities while at the same time exploring new ones. Defence acquisition is thus driven by two parameters: preparing the next generation of existing platforms to avoid any capability gap or loss of industrial capacities (exploring) and pushing the growth potential of existing technologies to maintain the technological edge vis-à-vis potential enemies (exploiting) (*Bellais & Droff*, 2017, p. 213).

Solutions to wicked problems are not true-or-false, but good-or-bad

Similarly to wicked planning-type problems, in which many parties are equally entitled to judge the solutions and none has the power to set formal decision rules to determine correctness (*Rittel & Webber*, 1973, p. 163), in defence acquisition, there are no independent judgment criteria. Depending on their level of knowledge, values, role and responsibilities, different stakeholders will assess threat scenarios differently and call for different solutions. For instance, a soldier on the battlefield whose life is at risk may judge the need for the latest battle tank technology differently than a four-star general at the Pentagon whose reputation is at stake or a politician in Washington whose primary focus is on winning the next elections.

In an attempt to address the judgment-assessment dilemma, *Snider* (2017, p. 199) proposes to change the role of the programme manager from a politically-neutral expert to an actor who has an appreciation for the needs and interests of other stakeholders as well as the conditions and circumstances of the acquisition environment. For *Snider* (2017, p. 199), the programme manager should act as a central and active catalyst in facilitating dialogue, relationships, and meaning creation among all participants. This would ultimately shift the focus from first-order learning and "doing things right" to second-order learning and "doing the right thing" and thus take into account the inherently wicked nature of defence acquisition (*Flood & Romm*, 1996).

Snider's (2017) call for more social value in defence acquisition is confirmed by *Lefeez* (2017b, 2014), who investigated the relationships between military leadership (État-major), the defence acquisition department (DGA) and the defence industry in France. *Lefeez* (2017b, 2014) highlights that the different groups expressed their

mistrust of one another and asked for more mutual confidence, pointing out that confidence was a central issue in the defence acquisition process. All things considered, *Lefeez* (2017b, 2014) concludes that military needs are not only determined by operational considerations, but also by social factors.

Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly

Rittel & Webber (1973, p. 163) underscore that with wicked planning-type problems, every implemented solution is consequential and leaves traces that cannot be undone, as opposed to traditional science problems (e.g. mathematics), in which the problem solver can try various runs without penalty. The same logic holds true for defence acquisition. A bad strategic development and/or acquisition choice cannot only result in a higher number of casualties on the battlefield but ultimately put the national security of a nation at risk (*Markowski et al.*, 2010, p. 18). Moreover, considering the importance that nations attribute to their defence budgets (NATO nations spent in total 2.57 per cent of GDP on defence in 2022), defence programmes also carry significant economic weight (*NATO*, 2022).

In order to get a better understanding of the "economic traces" that defence acquisition leaves behind, it is necessary to take a closer look into the functioning of the defence sector. The defence sector functions as a combination of a monopsony and an oligopoly. A monopsony describes a market structure in which a single buyer (the nation-state) substantially controls the market as the major purchaser of goods and services offered by many sellers, whereas an oligopoly describes a market condition in which a market is dominated by a small number of large sellers (defence companies) (*Markowski*, 2010, p. 120).

The hybrid market structure of the defence sector has basically two origins. First, because the state has the monopoly of the force, it is the only legitimate defence buyer. This however has important consequences for the seller. In a market with a single buyer, business opportunities are rare, and a major contract may represent a "must-win" deal for a seller company, where it may be forced to lay off workers and diminish its capability, perhaps leave the sector, or even go into liquidation if it does not prevail (*Taylor*, 2017, p. 30). For example, Hunting Engineering opted to leave defence when it lost its role at the Atomic Weapons Establishment and Vosper Thorneycroft gave up competing for ship development work and sold its shipbuilding business to BAE Systems (*Taylor*, 2017, p. 25).

Second, diminishing budgets, growth in global competition and increasing exposure to open market practices led to the merger and consolidation of both the US and EU defence industries (*Uttley*, 2018, p682). Today, the US market is dominated by five major defence companies, namely Lockheed Martin, Northrop Grumman, Raytheon, Boeing and General Dynamics, and the EU market by four major defence companies, namely BAE Systems, Airbus, Thales and Leonardo (*SIPRI*, 2022).

Depending on their defence profile, states use different strategies to protect and/or boost their defence technological and industrial base (DTIB). For instance,

states with a comparatively large defence sector like the UK or the US tend to follow an "identify and exploit export markets" approach. Yet, exporting to third-world buyers has also left their DTIB vulnerable to the shifting buying power of those states which often are dependent on the price of raw materials and fluctuating defence spending (*Bishop*, 2017, p. 66). By contrast, states with a small DTIB like Norway and Turkey use defence imports as a catalyst to acquire technology, either through reverse engineering, licensing or co-production, amongst other options, to be able to move up the technological ladder, with the aim of eventually becoming self-reliant (*Balakrishnan*, 2017, p. 267). For instance, Turkey assembled the F-16 fighter under a US licence from 1984 until 1999. However, despite gains in aircraft and composite parts production technologies and know-how, the local value-added remained disappointingly low –only about 8–9 per cent of the value of an F-16 fighter (*Güvenç & Yanik*, 2012, p. 117).

In defence acquisition, the practice of using technology from a foreign supplier as an economic development tool is known as "offsets". Offsets and its sister principle "juste retour" (principle of fair industrial return) are popular tools, particularly when highly advanced technology is involved (see *Matthews*, 2014). Especially smaller military powers such as Belgium and the Netherlands rely on offsets for maximising domestic industrial benefits, not least because they lack the domestic capacity to develop large-scale defence programs (*de France et al*., 2016).

However, the use of 'economically motivated' offsets remains controversial and has been outlawed under EU law (*Uttley*, 2018, p. 681). Indeed, following a 2012 Guidance Note on offsets from *Directorate General Internal Markets and Services*, the use of offset may only be justified by essential security interests of the state (Article 346 TFEU), whereas economic considerations exclude its use. In addition, no concrete evidence exists that general economic development goals are ever achieved via offsets (*Markowski & Hall*, 2014; *Brauer & Dune*, 2011. Unsurprisingly, offset practices and the "juste retour" principle have been exposed to sustained criticism and are seen by many as one of the main obstacles to the creation of a genuine European defence equipment market (*Calcara*, 2020; *Hartley*, 2020b).

The planner has no right to be wrong

By contrast to *Popper's* (1961) principle of science, in which solutions to problems are only hypotheses offered for refutation and thus part of the scientific truth-finding process, in defence acquisition, every developed solution (output) follows a particular aim (outcome) and has thus "no right to be wrong". Indeed, as mentioned elsewhere in the article, a bad strategic development and/or acquisition choice can have immense detrimental consequences for a nation, not only on the battlefield but also in economic terms. In this respect, programme managers are liable for the consequences of the actions they generate.

The Dreadnought battleship experience is a case in point. At the end of the 19th century, thick armour plating led to a revolution in warship design and the development of the Dreadnought battleship class (*Louth*, 2017, p. 41). At the time, it was believed that nothing could counter a fleet of such strength. However, the first major fleet-on-fleet clash of the First World War at Jutland in 1916 showed that

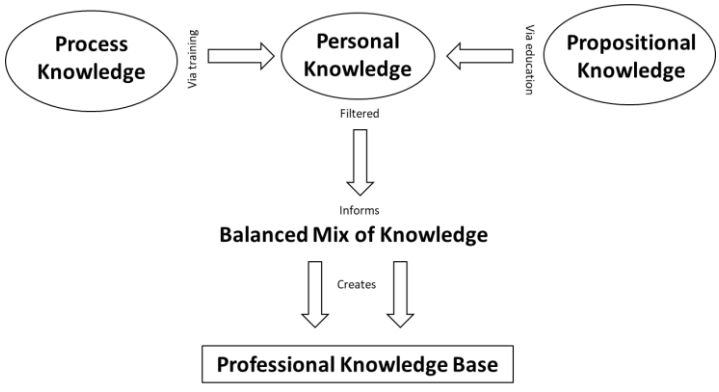
firepower anticipated from Dreadnought-derived ships was neither superbly accurate nor decisive. Moreover, admirals tended to be reluctant to risk their Dreadnought ships in combat as they were disproportionately valuable and strategically important, not least due to their enormous acquisition costs (*Louth*, 2017, p. 42).

A similar discussion currently revolves around the US aircraft carrier strategy. For many, the acquisition costs of an aircraft carrier do not match its strategic battle value (*Cochran*, 2018; *Rubel*, 2011). The main criticism is that aircraft carriers have become vulnerable to novel weapon systems such as loitering munition. In particular, it is argued that a swarm of attacking drones could inflict serious damage to an aircraft carrier. While defensive measures are able to cope with cruise missile attacks, their effectiveness is less clear when it comes to repelling loitering munition (e.g. drone swarm attack). Furthermore, the resources and capabilities needed to produce and operate a major platform system such as an aircraft carrier are in stark contrast to the resources and capabilities needed to acquire and deploy loitering munition.

Again, all comes down to good judgement and decision-making, or as *Moore* (2017) puts it, to be an "intelligent customer". For *Moore* (2017, p. 259), good (enhanced) decision-making in defence acquisition is the result of professional judgment based upon a balanced mix of knowledge. Most importantly, he sees training and education as key factors in the process. He argues that training builds "process knowledge" and that education builds "propositional knowledge", and that both are filtered through a perspective of "personal knowledge" to inform a "balanced mix of knowledge" which ultimately builds the "professional knowledge base" (*Moore* 2017, p. 259) (*Figure 4*).

Moore's concept of the "intelligent customer" is reminiscent of the Swedish experience. In Sweden, the "competent and demanding customer" (that is the Swedish Armed Forces) has not only contributed to the evolution of the Swedish (military) industry, but also actively supported the development of modern weapon systems, the latest being the Gripen combat aircraft. (see *Eliasson*, 2017, 2011, 2010, 2000, 1990).

Figure 4: The development process of a professional knowledge base in defence acquisition



Source: Redrawn from *Moore* (2017, p. 259)

CONCLUSION

Exploring defence acquisition through the lens of *Rittel & Webber's* (1973) wicked problem has shown that defence acquisition is best understood as an open system with dynamic causal web structures and uncertain intervention points, and not as a closed system with fixed boundaries and predictable cause-effect relationships. All eight investigated properties of a wicked problem have explanatory power and empirical value.

In particular, the analysis has pointed out that the contested value of defence outcomes combined with the unforeseeable character of threat scenarios contributes to the contingent nature of military capabilities. This creates an important lack of (reliable) information and knowledge, which ultimately leads to interpretation and judgment in defence acquisition.

Moreover, the analysis has shown that the US and UK defence acquisition frameworks fail to cope with the changing nature of defence acquisition. The reason is that the Linear Transformation Model, their structural base, relies on a straightforward "input-process-output-outcome" logic which is unable to account for the complex networked structure and connected workings inherent to defence acquisition.

While for some authors like *Moore* (2017), *Lefeez* (2017a, 2017b, 2014) and *Snider* (2017), the failures of the neoliberal policies and their reform agendas are best explained by a "problem of practice" (that is the need for a better practical and experiential understanding of the institutional logics that shape the defence acquisition process), for others such as *Burgess* (2017), the core issue is not a problem of practice but rather a "problem of theory" (that is the need for defence acquisition practice to be underpinned by a well-developed defence acquisition theory or meta-theory).

As an actor who has been working in defence acquisition for many years, the author supports both positions. On the one hand, it is true that the current defence acquisition practices contain substantial knowledge gaps and are driven by the "tyranny of the urgent" (*Burgess*, 2017) with immediate short-term outputs dominating over long-term strategic outcomes. Most importantly, if not addressed in a structural way (i.e. by developing a meta-theory that accounts not only for the technical processes but also for its hidden institutional logics), the existing knowledge gaps are likely to grow and amplify the systemic deficits in defence acquisition. On the other hand, the networked nature of defence acquisition begs for deeper practical knowledge of the relationship between structure and agency and how new institutional logics can be implemented at the individual level, that is how actors access the cultural resources (i.e. values, norms and beliefs) embedded within their social and professional networks to act as agents of change.

Further research on the theory-practice divide is necessary in order to transform the institutional culture of defence acquisition and remedy its systemic shortcomings. Considering the multiple reforms that defence acquisition has undergone since the end of the Cold War, it can be said that there is a genuine will to change defence acquisition for the better. By adopting a new perspective to the table, namely that of

defence acquisition as a wicked problem, the author hopes to make a positive contribution to defence acquisition.

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