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Legal Aspects of Additive Manufacturing in the Military Logistics

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ABSTRACT

The use of Additive Manufacturing (AM) in military logistics is limited by the uncertainty about the legal risks of using the method. The purpose of this study was to identify the potential legal risks associated with AM of military materiel and its effects. The study was conducted as a case study, where AM is considered in military logistics. Legal issues were approached from the normative point of view in the context of potential legal dispute situations in four different cases. The topic was studied by reviewing and analyzing literature sources, official sources, and Finnish Defence Forces military materiel purchasing contracts and interviews. The study interpreted and systematized the general principles of IPR and contract law when using AM in the military. An identified result of the study was that the use of AM to print military materiel under normal conditions may entail risks that should be contractually managed. In other cases, e.g. crises or wartime, there are risks, but they are difficult to predict and manage or are acceptable. The results of the study concern countries with a similar military economic system to Finland in terms of military logistics. The results can be applied

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to the activities of different security sectors, due to the similarity of their activities. The use of AM can enable the material to be used in safety situations where speed and versatility are required for material readiness. The use of the method requires a legal right, the holder of which has the right to manufacture the product. In different situations, the legal basis is open to interpretation and may pose risks to the decision-maker. The research will provide information to decision-makers for the preparation of contracts for the acquisition and maintenance of military material and implementing AM to military logistics.

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Introduction

Additive Manufacturing (AM) has rapidly emerged as a potential manufacturing method alongside traditional manufacturing methods.[1] Military AM has been typically used to develop new applications, tools, material maintenance, and repair.[2,3] Because of the recognized advantages, its use in military applications is being researched and tested.[4,5,6,7]

[1] T.T. Wohlers et.al., *Wohlers Report 2021*, Wohlers Associates Inc., Colorado, 2021.

[2] B.A. Zimmerman, E.E. Allen, *Analysis of the Potential Impact of Additive Manufacturing on Army Logistics*, Naval Postgraduate School, Monterey, 2013.

[3] D.S. González, A.G. Álvarez, *Additive Manufacturing Feasibility Study & Technology Demonstration*, Monterey, Brussel, European Defence Agency, 2018.

[4] J. den Boer, H. Lambrechts and H. Krikke, 'Additive manufacturing in military and humanitarian missions: Advantages and challenges in the spare parts supply chain', *Journal of Cleaner Production 2020*, vol. 257, no. 120301.

[5] González, Álvarez, 'Additive Manufacturing Feasibility Study & Technology Demonstration'.

[6] L.J. McLearen, *Additive Manufacturing in the Marine Corps*, Monterey, California, Naval Postgraduate School, 2015.

[7] M. Hokkanen, S. Rautio, *3D printing feasibility study*, Ylöjärvi, Finnish Defence Research Agency, 2018.

In addition to the benefits, it has been found that there are limitations to the use of the method.[8] Restrictions are very diverse in nature. In addition to technical limitations in equipment, materials, and applications, it is recognized that use may be limited by intangible factors such as legal.[9,10] Limitations imposed by legal factors can significantly hamper the deployment and wider use of the method as part of military logistics.

Supporting military operations in modern warfare is a prerequisite for successful battles.[11] The dangers of fighting and the environment are different from those of civil society. Therefore, the use of new technologies as part of support for the use of military capabilities in military logistics can bring significant benefits.[12]

The global crisis caused by the Coronavirus (COVID-19) prompted various countries, including Finland, to declare a state of emergency and to enact related legislation. In exceptional circumstances, the constitutional rights of the various actors were significantly restricted.[13,14] The crisis also showed a similar need for material preparedness by the various security authorities. The use of AM in various applications, such as manufacturing of critical medical protective equipment and parts, was reported very quickly as material availability declined and the shortage of parts became

[8] B. Lu, D. Li, X. Tian, 'Development Trends in Additive Manufacturing and 3D Printing', *Engineering*, 2015, pp. 85–89.

[9] M. Ballardini, M. Norrgård, J. Partanen, 3*D printing, Intellectual Property and Innovation*, 1st edn., AH alpen aan den Rijn: Kluwer Law International B.V., 2017, pp. 64–77.

[10] González, Álvarez, 'Additive Manufacturing Feasibility Study & Technology Demonstration'.

[11] US ARMY, *Commanders' Maintenance Handbook*, Washington DC, Headquarters Department of the Army, 2013.

[12] Zimmerman, Allen, 'Analysis of the Potential Impact'.

[13] The United States Government, 'Proclamation on Declaring a National Emergency Concerning the Novel Coronavirus Disease (COVID-19) Outbreak', 2020, https://www.whitehouse.gov/presidential-actions/proclamation-declaring-national-emergency-concerning-novel-coronavirus-disease-covid-19-outbreak/, (accessed 13 March 2020).

[14] YLE, 'Finland closes schools, declares state of emergency over coronavirus', *Yleisradio Finland*, 2020, https://yle.fi/uutiset/osasto/news/finland_closes_schools_declares_state_of_emergency_over_coronavirus/11260062, (accessed 16 August 2021).

apparent.[15,16,17,18] This unregulated use of AM raised questions concerning compliance with contractual supply in case of shortages and Intellectual Property Rights (IPR).[19]

The practical operation of maintenance requires agreements with suppliers, manufacturers and original equipment manufacturers (OEM) on spare parts, components, and performance. There is only limited information on the legal effects of new technologies, in particular AM, and its importance in military materiel contracting.[20,21,22] The confidentiality of contracts between armed forces and suppliers is the main reason for restricted access to information. By keeping the details of the treaties secret, Armed Forces seek to protect the disclosure of military activities. On the other hand, procurement is largely public, at least as far as procurement decisions are concerned. Likewise, there is little information on legal violations of military material. This may be due to the fact that manufacturers try to resolve potential disputes by settlement or that there is hardly any IPR enforcement against states.

There are currently no known Additive Manufacturing related IPR infringement cases in the western courts.[23] Armed forces and suppliers are pushing the limits of what is allowed and what is prohibited, and therefore

[15] Additive Manufacturing, '3D Printing and Coronavirus: U.S. Additive Manufacturers Share Their Experiences', *Additive Manufacturing G.B. Media*, May 2020, https://www.additivemanufacturing.media/blog/post/3d-printing-and-coronavirus-us-additive manufacturers-share-their-experiences, (accessed 15 June 2021).

[16] M. Salmi, J. S. Akmal, E. Pei, J. Wolff, A. Jaribion, S. Haghighat Khajavi, '3D Printing in COVID-19: Productivity Estimation of the Most Promising Open Source Solutions in Emergency Situations', *Applied Sciences*, vol. 10, no. 11, 2020.

[17] A. Petsiuk et.al., 'Partially RepRapable automated open source bag valve mask-based ventilator', *HardwareX*, vol. 8, no. e00131, 2020.

[18] N. Gallup et. al., 'Parametric nasopharyngeal swab for sampling COVID-19 and other respiratory viruses: Open source design, SLA 3-D printing and UV curing system', *HardwareX,* 2020, vol. 8, no. e00135.

[19] Salmi, Akmal, Pei, Wolff, Jaribion, Haghighat Khajavi, '3D Printing in COVID-19: Productivity Estimation of the Most Promising Open Source Solutions in Emergency Situations'.

[20] I. Flores Ituarte, S. Haghighat Khajavi, M. Salmi, 'Current and Future Business Models for 3D Printing Applications', in R.M. Ballardini, M. Norrgård and J. Partanen (eds.), *3D Printing, Intellectual Property and Innovation: Insights from Law and Technology*, WOLTERS KLUWER, 2017, pp. 33–62.

[21] Ballardini, Norrgård, Partanen, '3D printing, Intellectual Property and Innovation'.

[22] Salmi, Akmal, Pei, Wolff, Jaribion, Haghighat Khajavi, '3D Printing in COVID-19: Productivity Estimation of the Most Promising Open Source Solutions in Emergency Situations'.

[23] Ballardini, Norrgård, Partanen, '3D printing, Intellectual Property and Innovation'.

there are no clear principles for using the AM from a legal point of view. Therefore, there may be legal risks which may cause unforeseen effects.

Within the scope of this study, the main interests of legal aspects are related to the binding nature of contracts that may create the conditions for self-production through Additive Manufacturing. The most significant manifestations of the barrier to delivery are the potential violations of IPR. As digital manufacturing is gaining ground within the military sphere, it places pressure on all aspects of the intellectual property regime[24] as well as on the contract management of the military logistics.

In particular, the general question at hand is whether the unforeseen circumstances, i.e., for instance a state of war or an armed conflict, may have an effect on the enforceability of promises stated in the military contracts of sale or supply that the contract itself becomes frustrated. This would be a question of classical contract law that should be taken into account when drafting the contract itself.[25]

Further, the military contracts of sale have been drafted the same way and they contain the same exemption and force majeure clauses as their civilian counterparts. The most important clauses that come with the scope of our study would be these and those covering the aspects of the IPR.

The aim of this study is to determine how the legal factors should be considered when using AM in military logistics. This study focuses on cases where AM is used to maintain or repair a military structure acquired outside the Armed Forces. In the field of military logistics, this study focuses on the capability development and the use of the material as part of the performance. These factors are considered in four different Readiness Scenarios, i.e., Normal conditions (peacetime), Crisis, Wartime, and Host Nation Support (HNS).

This study provides information to military logistics decision-makers, military logistics personnel and personnel working on military acquisition and maintenance of how the legal aspects should be taken into account when using Additive Manufacturing in military logistics.

The remainder of this paper is organized as follows. Section two reviews literature of AM, legal framework and military contracting. This section presents the military environment to understand how it affects contracting

[24] T.R. Holbrook, L.S. Osborn, 'Digital Patent Infringement in an Era of 3D Printing', *UC Davis Law Review*, vol. 48, 2015, pp. 1319–1385.

[25] E. McKendrick, *Contract Law*, Palgrave, 1997.

and what we should consider when discussing military logistics. Section three explains the research methodology that includes the selection and analysis of 31 military material contracts and two interviews. The results of the analysis are presented in chapter four. In chapter four, we set the results to the risk framework to understand the implications of immaterial property rights. The paper concludes with a summary and final statements as well as a discussion and short outlook into future work.

Background

Additive Manufacturing

AM is a series of manufacturing processes whose first commercial applications were carried out in the late 1980s.[26] The printing material was polymers, and the method was called stereolithography (SLA).[27] The rapid development of the process took place in the 1990s,[28] when several different methods were developed for printing plastics. The first considerable applications for printing metal were developed with the advancement of laser technology.[29,30] Since then, the development of methods and materials has progressed year by year at an accelerating rate.[31] One of the main reasons for the development of the method has been the rapid development of technology, especially in computing speeds and computer applications.[32] Part of the reason for the development of the method, especially in the 2010s, has been the expiration of patents filed in the 1990s.[33] Today, AM

[26] J. Kruth, 'Material Incress Manufacturing by Rapid Prototyping Techniques', *CIRP Annals*, vol. 40, 1991, pp. 603–614.

[27] T. Wohlers, T. Gornet, *History of additive manufacturing – Wohlers report*, Wohlers Associates Inc., 2016.

[28] Wohlers, Gornet, 'History of additive manufacturing'.

[29] H. Lee et.al., 'Lasers in additive manufacturing: A review', *International Journal of Precision Engineering and Manufacturing-Green Technology*, no. 4, 2017, pp. 307–322.

[30] Wohlers, Gornet, 'History of additive manufacturing'.

[31] Wohlers, Gornet, 'History of additive manufacturing'.

[32] I.F. Ituarte, 'From rapid prototyping to digitalization: Steps on industrializing additive manufacturing', *Aalto University publication series DOCTORAL DISSERTATIONS*, 69/2017, 2017.

[33] I. Gibson, B. Stucker, D. Rosen, A*dditive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*, 2nd edn., New York, Springer Science + Business Media, 2015.

is widely used to produce prototypes,[34] end-use parts,[35,36,37] and tooling[38,39] in the medical,[40,41] automotive,[42,43] and military industries.[44,45]

What distinguishes AM from other manufacturing methods is that the final product is made by adding material layer by layer based on digital specification.[46,47,48] That digital description can be called a Blueprint, a 3D model or a computer-aided design (CAD) – model.[49] When producing additively manufactured parts, the CAD model needs to be transferred to the AM machine where the layer by layer stitching takes place. AM machines can

[34] Wohlers et.al., 'Wohlers Report 2021'.

[35] J.S. Akmal, *Unique Component Manufacturing Through Direct and Indirect Additive Manufacturing*, Espoo, Aalto University, 2017.

[36] S. Metsä-Kortelainen et.al., 'New business from digital spare parts' *VTT Technical Research Centre of Finland*, Espoo, 2020.

[37] M. Salmi et.al., 'Digital Spare Parts', *VTT Technical Research Centre of Finland*, Espoo, 2018.

[38] K. Jalava et.al., *Multi-Scale Topologically Optimized Components Made by Casting and Additive Manufacturing*, 73rd World Foundry Congress, Krakow, Poland, 2018.

[39] Wohlers et.al., 'Wohlers Report 2021'.

[40] J.S. Akmal et.al., 'Implementation of Industrial Additive Manufacturing: Intelligent Implants and Drug Delivery Systems', *Journal of Functional Biomaterials*, vol. 9, no. 3, 2018.

[41] J.S. Akmal et.al., 'Cumulative Inaccuracies in Implementation of Additive Manufacturing Through Medical Imaging, 3D Thresholding, and 3D Modeling: A Case Study for an End-Use Implant', *Applied Sciences*, vol. 10, no. 8, 2020.

[42] Wohlers et.al., 'Wohlers Report 2021'.

[43] BMW Group, 'New technology campus for 3D printing goes on stream: BMW Group builds on additive manufacturing, with skills consolidated at single site', *BMW*, June 2020, https://www.press.bmwgroup.com/global/article/detail/T0309872EN/new-technology-campus-for-3d-printing-goes-on-stream:-bmw-group-builds-on-additive-manufacturing-with-skills-consolidated-at-single-site?language=en, (accessed 15 June 2021).

[44] S.H. Khajavi, J. Partanen, J. Holmström, 'Additive Manufacturing in the Spare Parts Supply Chain', *Computers in Industry*, vol. 65, no. 1, 2014, pp. 50–63.

[45] Wohlers et.al., 'Wohlers Report 2021'.

[46] Gibson, Stucker, Rosen, 'Additive Manufacturing Technologies'.

[47] J. Tuomi, *Rapid Prototyping Applications and Effects of the Applications on Companie" Product Development Processes*, Helsinki, Helsinki University of Technology, 2003.

[48] SFS-ISO/ASTM, '52900:2016 Additive manufacturing -- General principles -- Terminology', SFS-ISO/ASTM, 2016

[49] Ballardini, Norrgård, Partanen, '3D printing, Intellectual Property and Innovation'.

use different materials[50] and different joining methods.[51] After printing, the part is typically not ready for use. Depending on the requirements of the part, it may need to be postprocessed.[52]

Three stages can be identified in the AM production process – pre-printing, printing, and post-processing phases.[53] The printable model can be created from images, structural drawings of the part, or by reverse-engineering the original part. Cameras, scanners, and various software can be used to help with the design.[54]

During the pre-printing stage, the model needs to be sliced and converted to a format that the printer understands. At the printing stage, the most appropriate AM method and material are selected that fulfil the functional integrity of an item to be manufactured.[55,56] The software in the printer controls the mechanical, electrical or both devices of the printer according to the imported model to produce the part. After printing, the part is removed from the printer, mechanically if necessary.

Then, the part is post-processed if necessary. Requirements may have been set for the item before printing. Due to the AM method and techniques, these requirements may not be met for as-built parts. As a result, the part may need to be post-processed to meet requirements, typically using traditional methods.[57]

[50] D. Bourell et.al., 'Materials for additive manufacturing', *CIRP Annals*, vol. 66, no. 2, 2017, pp. 659–681.

[51] SFS-ISO/ASTM, '52900:2016 Additive manufacturing -- General principles -- Terminology', SFS-ISO/ASTM, 2016.

[52] Gibson, Stucker, Rosen, 'Additive Manufacturing Technologies'.

[53] M. Salmi, 'Additive Manufacturing Processes in Medical Applications', *Materials*, vol. 14, no. 191, 2021.

[54] Gibson, Stucker, Rosen, 'Additive Manufacturing Technologies'.

[55] D. Bourell et.al., 'Materials for additive manufacturing', *CIRP Annals*, vol. 66, no. 2, 2017, pp. 659–681.

[56] Gibson, Stucker, Rosen, 'Additive Manufacturing Technologies'.

[57] Gibson, Stucker, Rosen, 'Additive Manufacturing Technologies'.

Additive Manufacturing has been forecasted to be the New Industrial Revolution.[58,59,60] The revolution refers to the ability of the method to produce parts in a way that has never been possible before. Compared to traditional manufacturing methods, the advantages of AM have been identified, both in terms of providing the method with near-independent geometry and in the capabilities of the manufacturing environment.[61]

The advantages over conventional manufacturing have been identified as follows as derived from the literature:[62,63]

- manufacturing without tooling
- reducing the geometry constraints of the parts being manufactured
- the design can be quickly changed, customized and optimized for function
- small batches production
- scalability
- faster manufacturing speed that can be achieved by simplifying supply chains
- use of printers in non-industrial environments
- enabling cost-effective production of single parts
- reducing waste

The military use of Additive Manufacturing has been researched and tested around the world.[64,65,66,67,68] The use of the method in new military

[58] B. Berman, '3D-printing; The new industrial revolution', *Business horizons*, vol. 55 issue 2, 2012, pp. 155–162.

[59] R.M. Mahamood et.al., 'Revolutionary Additive Manufacturing: An Overview', *Lasers in Engineering*, vol. 27, no. issue 3/4, 2014, pp. 161–178.

[60] M.J. Walker, 'Hype cycle for emerging technologies', *Gartner, Inc.*, 2017, https://www.gartner.com/, (accessed 21 July 2021).

[61] S. Ford, M. Despeisse, 'Additive manufacturing and sustainability: an exploratory study of the advantages and challenges', *Journal of Cleaner Production*, no. 137, 2016, pp. 1573–1587.

[62] Gibson, Stucker, Rosen, 'Additive Manufacturing Technologies'.

[63] J. Holmström et.al., 'Rapid manufacturing in the spare parts supply chain: Alternative approaches to capacity deployment', *Journal of Manufacturing Technology Management*, vol. 21, no. 6, 2010, pp. 687–697.

[64] Additive Center, 'Royal Dutch Army: Increasing adaptability on the battlefield with 3D printing', 2020, https://additivecenter.com/2020/01/23/royal-dutch-army-increasing-adaptability-on-the-battlefield-with-3d-printing/, (accessed 15 January 2021).

[65] Headquarters United States Marine Corps, 'Marine Corps Order 4700.4 - Additive Manufacturing Policy', *Department of Defence – Department of the Navy*, Washington DC, 2020.

[66] González, Álvarez, 'Additive Manufacturing Feasibility Study & Technology Demonstration'.

[67] Hokkanen, Rautio, '3D printing feasibility study'.

[68] McLearen, 'Additive Manufacturing in the Marine Corps'.

applications, new concepts and materials is constantly being explored. The material support needed for military operations is a key element of the military performance.[69] Maintaining performance is a crucial element of Military operations.[70,71]

A long life cycle of military materiel is constantly causing obsolescence, mainly due to the material development structure.[72] Military materiel is procured from a supplier in anticipation of a crisis.[73] Countries, in particular small, typically purchase materiel for the whole life cycle. From the point of view of security of supply, the materiel must also be in the user's possession in the event that access to spare parts is prevented.[74] It has been recognized that the capability to maintain and repair materiel is often based on predictions.[75] In the long-life materials, it means that prediction should be done during the procurement phase. By using AM, there is potential to solve the obsolescence problem by replenishing the line of replacement units by on-demand production.[76,77]

Especially in the security sector, supply chain disruption may entail significant problems in obtaining or repairing the material needed for security tasks. The risks for the disruption in the AM supply are not eminent because it does not require a high degree of asset-specificity in contrast to the conventional supply. AM acts as a general-purpose technology for the production of multiple parts each with a different design and shape compared to the conventional supply in which supply chains are designed according to a specific part type.[78] When the legal and technical aspects of

[69] Department of Defence, 'Department of Defense Additive Manufacturing Strategy'.

[70] Finnish Defence Forces, *Kenttähuolto uudistuu – Huolto taistelee ja tukee*, Helsinki, 2015.

[71] US ARMY, 'Commanders' Maintenance Handbook'.

[72] RAND, Europe, 'Additive manufacturing and obsolescence management in the Defence context', *Rand*, 2015.

[73] Pääesikunta, 'Pvohjek-Pe Suorituskyvyn Rakentaminen Ja Ylläpito', *Puolustusvoimat – Finnish Defence Forces*, Helsinki, 2014.

[74] Finnish MoD, *Puolustushallinnon Materiaalipolitiikka*, Helsinki, Finnish Ministry of Defence, 2011.

[75] Pääesikunta, 'Pvohjek-Pe Suorituskyvyn Rakentaminen Ja Ylläpito'.

[76] RAND, Europe, 'Additive manufacturing and obsolescence management in the Defence context', *Rand*, 2015.

[77] González, Álvarez, 'Additive Manufacturing Feasibility Study & Technology Demonstration'.

[78] J.S. Akmal et.al., 'Switchover to industrial additive manufacturing: Dynamic decision-making for problematic spare parts', In review in the *International Journal of Operations & Productions Management* in the year 2022.

parts are prepared for a potential switchover to AM, it enables a dynamic supply of parts from multiple AM machines and suppliers concurrently as opposed to a static supply for conventional manufacturing.[79]

Military Materiel contracting frameworks

Overall, military capability in the military field is defined as dualistic - it is 1. crucial enabler for a centre of gravity and 2. necessary to the accomplishment of the specified or assumed objectives.[80,81,82,83] Typically, the material capability development of armed forces in small countries is mainly based on procurement. The purpose of the procurement is to provide the material performance required by the Armed Forces as efficiently and economically as possible.[84] The use of performance is aimed at achieving the military objectives set.[85] Achieving military objectives depends on performance being sufficiently proportionate to the threat and the ability to use the capabilities as intended. Adequate logistical support is a prerequisite for the use of military materiel. In principle, this means maintenance of the materiel.[86,87,88] Maintenance is based on a logistical solution, which can be in-house (Armed Forces), outsourced or a combination of these.[89]

[79] Akmal et.al., 'Switchover to industrial additive manufacturing: Dynamic decision-making for problematic spare parts'.

[80] Australia Department of Defence, 'Defence Capability Development, Acquisition and Disposal', *National Archives of Australia*, 2017.

[81] Office of the Chairman of the Joint Chiefs of Staff, 'DOD Dictionary of Military and Associated Terms', US the Joint Staff, Washington DC, 2020.

[82] Pääesikunta, 'Pvohjek-Pe Suorituskyvyn Rakentaminen Ja Ylläpito'.

[83] NATO, NATO Logistics Handbook, Brussel, NATO HQ, *Defence Policy and Planning Division, Logistics Capabilities Section, 2012.*

[84] Finnish MoD, 'Puolustushallinnon Materiaalipolitiikka'.

[85] B. Taylor, 'Analysis Support to Strategic Planning', The Technical Co-Operation Program, Australia - Canada - New Zealand - United Kingdom - United States of America, 2013, https://cradpdf.drdc-rddc.gc.ca/PDFS/unc194/p801995_A1b.pdf, (accessed 1 August 2021).

[86] Pääesikunta, Pvohjek-Pe Puolustusvoimien Toiminta, Helsinki, Finnish Defence Forces, 2017.

[87] US ARMY, 'Commanders' Maintenance Handbook'.

[88] US ARMY, General Supply and Field Services Operations ATP 4-42, Washington DC, US ARMY, 2014.

[89] Pääesikunta, Pvohjek-Pe Puolustusvoimien Toiminta, Helsinki, Finnish Defence Forces, 2017.

Military capability consists of material, personnel, and the principles of the operation of troops.[90] Capability is built on a need-based and threat-driven basis.[91] This means that capability development is based on an identified performance gap that is projected to the threat. Material performance is maintained in projects where the requirements are described in the concept.[92] The concept provides the basis for the need for performance and describes its integration into the military system.[93,94]

The aim of the project that will fill the performance gap is to provide the most cost-effective overall solution.[55] Various suppliers are asked for solution options for a complete solution. Evaluating the totality of these alternatives will determine which solution fills the gap.[95] As part of the overall solution, a material project will be set up that will be responsible for procuring the materiel.[96] This materiel solution for delivering performance and maintenance throughout its life cycle.[97]

A detailed contract will be drawn up with the winner of the tender. The contract shall specify the details regarding the use, maintenance and different stages of the life cycle of the materiel.[98] Different contracts are drawn up for different performances. In large projects, the materiel project is divided into several parts.[99] Special materiel for maintenance, such as spare

[90] Office of the Chairman of the Joint Chiefs of Staff, 'DOD Dictionary of Military and Associated Terms', US the Joint Staff, Washington DC, 2020.

[91] NATO, NATO Logistics Handbook, Brussel: NATO HQ, Defence Policy and Planning Division, Logistics Capabilities Section, 2012.

[92] Pääesikunta, 'Pvohjek-Pe Suorituskyvyn Rakentaminen Ja Ylläpito'.

[93] H. de Nijs, 'Concept Developement and Experimentation Policy and Process: How Analysis Provides Rigour', North Atlantic Treaty Organisation, Norfolk, 2010.

[94] NATO, NATO CD&E Handbook A Concept Developers Toolbox 2.01, Norfolk: Allied Command Transformation, Deputy Chief of Staff for Policy and Plans, Concept Development Division, 2021.

[95] Office of the Chairman of the Joint Chiefs of Staff, 'DOD Dictionary of Military and Associated Terms', US the Joint Staff, Washington DC, 2020.

[96] Pääesikunta, 'Pvohjek-Pe Suorituskyvyn Rakentaminen Ja Ylläpito'.

[97] Finnish MoD, 'Puolustushallinnon Materiaalipolitiikka'.

[98] Finnish Defence Forces, 'Pvhsmk – Pe Puolustusvoimien Hankintamääräys', Finnish Defence Forces HQ, Helsinki, 2015.

[99] Finnish Defence Forces, 'Pvhsmk – Pe Puolustusvoimien Hankeohje', Finnish Defence Forces HQ, Helsinki, 2015.

parts, will either be the subject of a separate agreement or will be procured at the project's expected cost.[100]

Traditionally, the armed forces have not themselves produced the materiel needed for performance. IPR are typically owned by the OEM. In some cases, where the armed forces have participated in the development of the material, the rights or some of the rights may have been distributed. Typically, the OEM has managed the rights and licensed them to sub-factories or manufacturers.[101] The OEM has provided subcontractors with the information needed to produce the material. The U.S. Armed Forces have recognized the challenge of owning IPR rights. It has introduced a new IPR policy in 2018. The purpose of the policy is to seek the acquirement of IPR rights for oneself in connection with procurement.[102] From an industry perspective, the challenge is that after the sale, the government's right to use, modify, adapt, distribute, reproduce, or disclose intellectual property rights may reveal the company's core business. Another challenge may be that the public operator can exercise the right to grant licenses to the parties of its choice, with commercial operators suffering when the public operator no longer commits to a long-term contract.[103]

Military Operating Environment – Readiness Scenarios

The advantages and limitations of AM are typically considered in the normal operating environment of the manufacturing industry. For military use, the method should be considered in a military operating environment. The military environment depends on the chosen doctrine.[104] In order to

[100] NATO, NATO CD&E Handbook A Concept Developers Toolbox 2.01, Norfolk: Allied Command Transformation, Deputy Chief of Staff for Policy and Plans, Concept Development Division, 2021.

[101] Under Secretary of Defense For Acquisition, Technology And Logistics, 'Intellectual Property: Navigating Through Commercial Waters', Department of Defense United States of America, 2001.

[102] US ARMY, 'Army secretary approves new Intellectual Property Management Policy', December 2018, https://www.army.mil/article/214881/army_secretary_approves_new_intellectual_property_management_policy, (accessed 8 April 2020).

[103] H. Harper, 'Army Takes on IP Rights Conundrum', *National Defense Magazine*, August 2019, https://www.nationaldefensemagazine.org/articles/2019/8/16/ndia-policy-points-army-takes-on-ip-rights-conundrum, (accessed 25 August 2021).

[104] NATO, 'NATO STANDARD AJP-01 ALLIED JOINT DOCTRINE', NATO STANDARDIZATION OFFICE (NSO), 2017.

address these circumstances, we have described the key drivers for legal factors in four different Readiness Scenarios.

Readiness Scenarios are based on three readiness states: peacetime, crisis, and war.[105,106] The fourth scenario, Host Nation Support (HNS) is based on the recognized special case in which factors from a legal point of view make it different from readiness states.[107] The main reason is that in HNS operations forces need to operate away from the fixed infrastructure.

Table 1 describes the Readiness Scenarios from the perspective of 8 different factors under 3 readiness states and the special HNS case. National risk assessment 2018, National Emergency Supply Agency – Threats to critical infrastructure and services 2020, and The Security Strategy for Society 2017 have been used to construct the Readiness Scenarios.[108,109,110]

Table 1. Readiness Scenarios as a function of critical factors in military logistics

Factors	Peace Time	Crises – lower than war
Contracting	Contract activities aim at cost-efficiency	The aim of contracting is to ensure availability – all organizations need to be prepared for a rapid aggregation

[105] National Emergency Supply Agency, 'The New Normal of Security of Supply - Scenarios for a post-COVID world and their impacts on security of supply 2020', *Finnish National Emergency Supply Agency*, 2020, https://www.huoltovarmuuskeskus.fi/files/629655466c8cb8a225d054c959ddc05bf6fa40d4/the-new-normal-of-security-of-supply.pdf/, (accessed 10 August 2021).

[106] J.G. Herrera, *The Fundamentals of Military Readiness*, Washington DC, U.S. Defense/Congressional Research Service, 2020.

[107] Pääesikunta, *Pvohjek-Pe Puolustusvoimien Toiminta*, Helsinki, Finnish Defence Forces, 2017.

[108] NATO, 'NATO STANDARD AJP-01 ALLIED JOINT DOCTRINE', NATO STANDARDIZATION OFFICE (NSO), 2017.

[109] Ministry of the Interior, *National risk assessment 2018*, Helsinki, Finnish Ministry of the Interior, 2019.

[110] The Security Committee, *The Security Strategy for Society*, Helsinki, The Security Committee, 2017.

Factors	Peace Time	Crises – lower than war
Circumstance legislation	Rights owners shall be fully protected by law	Difficult enforcement of emergency legislation – Protection of rights holders in all respects – Not only material but also material rights – Protection loses only after law implementation
Logistical disruption	Logistics is not disturbed	Logistics disruption – economic and political countermeasures or unexpected offers of cooperation – possible isolation
Community support	The structures of society enable products to be produced as planned	Destruction of the structures of society – disruption of product production and raw materials – disruption of energy supply
Use of military materiel	There is no military threat – the use and wear of military materiel is predictable	Military Threat to Asymmetric and Hybrid Warfare – Increased use of military material – Increased wear – Limited kinetic influence
Preparedness	Preparation is based on the security of supply and contracts	Emergency resources need to be deployed – preparing to use security resources

Factors	Peace Time	Crises – lower than war
Supply chains	Supply chains sleep, activate only by force	Supply Chain activation starts – Changing supply chains with contract operations slower than legislation
Resources	Plenty of resources relative to troops – strategic partnerships work	The number of troops is increasing – the ratio of available resources to used resources is decreasing – strategic partnerships

Factors	Wartime	Host Nation Support (HNS)
Contracting	The transition from contract activity to force majeure – Contracts are no longer valid in all respects – Expiry of contracts	Contracting is based on international state agreements – Materiel contracts based on national contracts – Materiel contract deliveries via international logistics – National contracts are valid depending on performance barrier
Circumstance legislation	Exceptional legislation in force – rightsholders still have legal protection – possibility to take rights in addition to material and non-material property	National law in normal or exceptional circumstances – continued protection for holders of rights – international protection available depending on national law – subject to the law of the host nation but with respect to the protection

Factors	Wartime	Host Nation Support (HNS)
Logistical disruption	Significant disruptions in logistics – aim to isolate and prevent the import of material and services	Logistics may be disrupted – The supported team will provide logistical support – Preparations allow readiness – Challenge that EU or UN clauses cannot determine which country's material is used in a joint operation
Community support	Breaking down the structure of society – preventing financial flows – preventing energy supply – disrupting raw materials	Exploit of the structures of society – isolation is damaging – potential disruption
Use of military materiel	Military threat transformation to more kinetic – maximizing the use of military material – in addition to wear, kinetic influence – damage repair changes from wear to kinetic impact	A military threat may be high – efforts to maximize the use of military materiel in joint operations – a significant expansion of materiel range
Preparedness	Maximizing Reserve Resources – Optimizing and Maximizing Resource Use	Maximum use of contingency resources – contingency resources may need to be utilized to the benefit of another state's performance – optimization of security of supply resources
Supply chains	Fully activation of supply chains	The fully mobilizing of supply chains internationally
Resources	Troops full of strength – Field Force Logistics System – Strategic Partnerships	Set of strengths – International Logistics System – Strategic Partnerships and International Partnerships

The legal framework of using Additive Manufacturing in the Military Logistics

Central to the legal review of AM is the examination of the legality of the use of the method. The review of legality should consider which law, or if the law does not apply, under which agreement the use of the method would be prohibited. With regard to the use of AM, it is essential to recognize that the parts are made on the basis of a digital specification and that the final product is an independent new product.

It is not self-evident which parts, products or components receive copyright protection at any stage of the AM production process. One example of this is the CAD model on which printing is based. A design may be an independent work that may be protected, but on the other hand, the design may be copied into digital form and then only partially edited from an original work already made by someone else.[111]

The use of AM allows the parts to be edited very far, which is why the question is also whether the product is completely new or a copy of something existing. If a part is completely new and not a copy of any previously created product, it will receive rights based on the new value. If it is a copy, when does it require the express permission of the OEM.

From the point of view of military use, it is necessary to know legally how and on what laws the acquisition of military material is based and, therefore, which laws affect the interpretation of laws in 3D printing of military material. Knowledge of the law is also essential because the order in which the contract is interpreted in relation to the law affects the possible interpretation of an infringement of intellectual property rights and an insurmountable obstacle.[112,113,114]

[111] S. Friesike et.al., 'Creativity and productivity in product design for additive manufacturing: Mechanisms and platform outcomes of remixing', *Journal of Operations Management*, vol. 65, 2019, pp. 735–752.

[112] US ARMY, 'Army secretary approves new Intellectual Property Management Policy', December 2018, https://www.army.mil/article/214881/army_secretary_approves_new_intellectual_property_management_policy, (accessed 8 April 2020).

[113] Under Secretary of Defense For Acquisition, Technology And Logistics, 'Intellectual Property: Navigating Through Commercial Waters', Department of Defense United States of America, 2001.

[114] Zimmerman, Allen, 'Analysis of the Potential Impact'.

In military logistics, the use of AM has been identified as providing added value, especially in maintenance.[115,116,117,118] In this case, the interest is legally focused on whether spare parts can be printed without separate OEM consent and, if so, on what basis.

The most important laws from the point of view of intellectual property law are the four laws of copyright and industrial property law: Design law, Patent law, Trademark law and Copyright law.[119,120] In addition to this, it is important to pay attention to how the force majeure clause is laid down in the contract in a changing military environment.[121,122] This may vary from country to country but is followed in most western countries.

IPR can be divided into industrial and copyright property.[123] Industrial property rights must be registered, copyright property rights are given to persons over the creations of their minds. Exclusive rights to a trademark or a business name may be obtained in the absence of registration by establishing the trademark or the business name through the use.[124] With regard to the military use of AM, neither aspect can be ignored. When a modeller makes a CAD model, he or she may acquire the right to the model he or she has made on the basis of copyright property.[125] On the other hand, a company may have a patent for a product it manufactures that it has sold for military use.

Historically, the industrial and intellectual property rights came into existence along with the enlightenment project and the birth of the market

[115] Additive Center, 'Royal Dutch Army'.

[116] Headquarters United States Marine Corps, 'Marine Corps Order 4700.4 - Additive Manufacturing Policy', Department of Defence – Department of the Navy, Washington DC, 2020.

[117] Hokkanen, Rautio, '3D printing feasibility study'.

[118] González, Álvarez, 'Additive Manufacturing Feasibility Study & Technology Demonstration'.

[119] Ballardini, Norrgård, Partanen, '3D printing, Intellectual Property and Innovation'.

[120] Holbrook, Osborn, 'Digital Patent Infringement in an Era of 3D Printing'.

[121] M. Polkinghorne, C. Rosenberg, 'Expecting the Unexpected: The Force Majeure', *Business Law International*, vol. 16, no. 1, 2015, pp. 49–64.

[122] R. Lombardi, 'Force Majeure in European Union Law', *International Trade and Business Law Annual*, vol. 3, 2015, pp. 81–106.

[123] European Union, *Protecting intellectual property rights in the EU*, Brussels, European Union, 2020.

[124] D. Mendis et.al., *The Intellectual Property Implications of the Development of Industrial 3D Printing*, Brussels, European Commission, 2020.

[125] European Union, 'Protecting intellectual property rights in the EU'.

economy.[126] They gained ground to foster innovation, entrepreneurship, and individual freedom. In the western world, the market economy is the major force that enables militaries to deploy and prevail on the battlefield. Hence, very little changes in time of war as far as the contracts and intellectual property rights are being concerned.[127] The military must thus obey the law and balance its interests with the rights of a free man.

The aforementioned contract for the procurement of military equipment is based on the Sale of Goods Act. The agreement can be used to agree on commercial matters, which in many cases exceed the obligations of the legislation applicable in an inappropriate situation. The form and content of the agreement have a significant impact on how technological developments can be considered with regard to intellectual property rights.[128,129] Even if the written form of the bargain seems to be very discrete, there are a number of institutions, such as implied terms and estoppels, that bring relational elements to the transaction.[130] Another question for a contract drafter is how to make a contract flexible as to serve the parties efficiently in the unforeseen future.

Furthermore, one of the major problems of modern and classical contract law is the extent of foresight required from the contracting parties at the time the contract was made, specifically in the military environment.[131] Some guidance to the question can be found in positive law: According to the Finnish Sale of Goods Act, section 27, "the buyer is entitled to damages when the seller's performance has been delayed, unless the seller proves that the delay was due to an impediment beyond his control which he could not reasonably be expected to have taken into account at the time of the conclusion of the contract and whose consequences he could not reasonably

[126] G. Ghidini, *Rethinking Intellectual Property – Balancing Conflicts of Interest in the Constitutional Paradigm*, Cheltenham, Edward Elgar Publishing Limited, 2018.

[127] The European Court of Human Rights, 'CASE OF ANHEUSER-BUSCH INC. v. PORTUGAL 73049/01 (Application no. 73049/01 p.)', The European Court of Human Rights, 2007.

[128] Ballardini, Norrgård, Partanen, '3D printing, Intellectual Property and Innovation'.

[129] Holbrook, Osborn, 'Digital Patent Infringement in an Era of 3D Printing'.

[130] A. Scales, L. Spitz, 'The Jurisprudence of the Military-Industrial Complex', *Seattle Journal for Social Justice 1*, no. 3, 2013, pp. 541–566.

[131] The European Court of Human Rights, 'CASE OF ANHEUSER-BUSCH INC. v. PORTUGAL 73049/01 (Application no. 73049/01 p.)', The European Court of Human Rights, 2007.

have avoided or overcome."[132] The most difficult part of this "control liability -doctrine" are the questions of reasonable prudence and that of avoidance. In addition, with globalization these problems are highlighted as the production of military materiel involves several countries and the risk that come with the phenomenon are ever harder to forebode.[133]

In several countries, there are exceptions to the legislation for possible exceptions. Finland has legislation that can be introduced in exceptional circumstances. This legislation can be used to expropriate property and special rights, such as intellectual property rights, for defence purposes. This Act (1301/1996) concerns the redemption of property and special rights for the performance of the tasks assigned to the Defence Forces. This can be considered nationally, but it is not clear how legislation affects internationally procured military material.

To sum up the aforementioned, the contract is the means – and by far the only viable one – to secure the option to use AM to secure the supply of critical components. To be more precise, the traditional force majeure and hardship clauses work against the interests of a military organization. If such clauses are put forward in the contract by the military, it is next to impossible to rely on the statutory institutions to secure the seller's performance in exceptional circumstances. Secondly, the contract is the best way to make sure that the IPRs do not pose a threat to alternative methods of performance. The aforementioned notions and the strict indemnity clauses may demand renegotiations, new methods of contract drafting, and a new kind of IPR management from the suppliers of military materiel for the deployment of AM in the military logistics.

Methods

The material in this study includes literature, official sources, and contracts for the acquisition of military materiel by the Finnish Defence Forces.

The material of this study has been the Finnish Defence Forces contracts on the acquisition of military equipment (n = 31). In particular, the intellectual property sections of the agreements have been interpreted and analyzed in relation to the production of the material. IPR and related legislation were examined through nationally, EU, and international contract law provisions. Two interviews were conducted to review the current status of the General IPR in Finnish Defence Forces. Interviewees work as

[132] Finlex, 'Finnish Sale of Goods Act', Finlex, 1987.

[133] I. Schwenzer, 'Force Majeure and Hardship in International Sales Contracts', *Victoria University of Wellington Law Review*, vol. 39, no. 4, 2008, pp. 709–726.

a Commercial Legal Expert for Procurement and an Immaterial Property Rights expert. Contracts and interviews were systematized and classified from a legal point of view. The factors of systematization and classification were examined in relation to the intellectual property provisions of the contracts, concluded by the Finnish Defence Forces in connection with the procurement of materiel.

This study examines the military operating environment where the chosen military solution does not carry out operations outside its own country. This also automatically means that different degrees of crisis can be identified militarily. In this study, the Finnish Defence Forces doctrine is used as the military operating environment. The different degrees of crisis are viewed from a national perspective.

Study Design

The research method used in conducting this work can be described through triangulation:[134] It combines jurisprudence in various forms such as theoretical and practical legal dogmatic method and legal realism together in order to find pragmatic legal solutions to the research question.

The study was conducted as a case study[135] where AM and related legal issues were considered from the perspective of military materiel. Case study research in logistics can be divided into six different categories according to Astrup and Haldeson (2008) and Dinwoods and Xu (2008). To this end, this study is exploratory, theory-based, and theory-defining.[136,137]

This exploratory case study investigates a phenomenon for which only limited information is available. Particularly from a military perspective, the lack of existing research limits the choice of methodology.

In this study, we identified that a key factor in the analysis is the circumstance in which legal considerations are interpreted. From the point of view of military action, the circumstance determines the solutions that are

[134] N. Carter et.al., 'The Use of Triangulation in Qualitative Research', *Oncology Nursing Forum*, vol. 41, no. 5, 2014.

[135] R.K. Yin, *Case study research design and methods*, 4th edn., Thousand Oaks, Sage Publications, 2009.

[136] J. Aastrup, Á. Halldórsson, 'Epistemological role of case studies in logistics: acritical realist perspective', *International Journal of Physical Distribution and Logistics Management*, vol. 38, no. 10, 2008, pp. 746–763.

[137] J. Dinwoodie, J. Xu, 'Case studies in logistics: a review and tentative taxonomy', *International Journal of Logistics Research and Applications*, vol. 11, no. 5, 2008, pp. 393–408.

made in the situation. Circumstances can change rapidly and indefinitely. That means conditions can change directly from normal conditions to a state of war without an interim crisis.

From the point of view of legal dogmatic, the legal system acts as binding or valid standards. Legitimate considerations are seen as a state coercive order that involves the use of coercive power to enforce standards. The study looked at legal issues from the normative point of view.

In this study, we analyzed contracts (number of contracts n=31) for military materiel under the circumstances of the Readiness Scenarios defined in section 2.2. The legal analyzes performed and the interpretations form the basis of this study. Therefore, the cases of the study have been defined as they appear from a state perspective. Figure 1 shows the process of evaluating each military procurement contract. The process ensures that the critical parties, i.e., military logistics actors, legal interpreters, and decision-makers, are considered in evaluating the military contracts for the potential AM deployment.

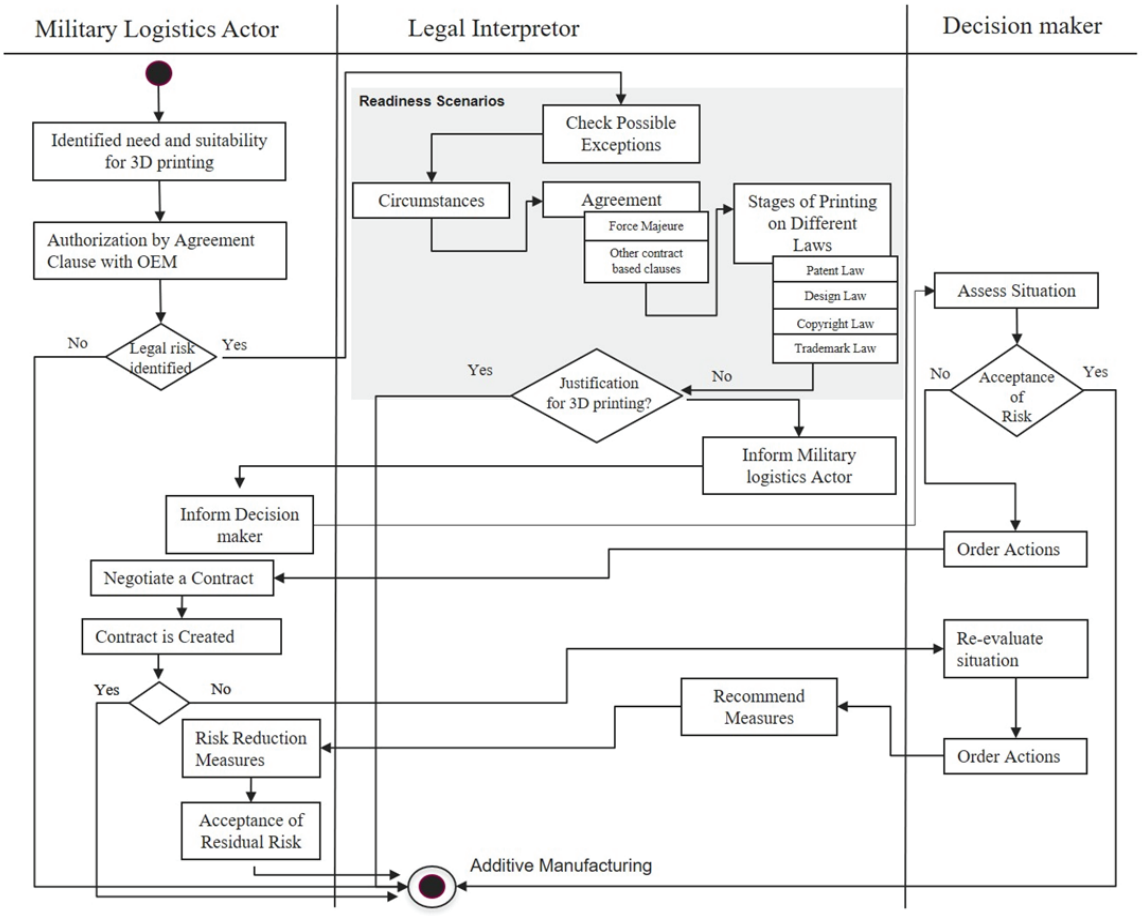
The study was carried out by classifying the effects of the specific features of AM in relation to different laws. Grouping the legal clauses of existing contracts and identifying the potential risks involved in the usage of AM in different situations were conducted. The nature of the performance barriers included in the contracts was identified. The interpretation of the various laws on performance barriers and intellectual property law was formed by understanding the effects they have on different areas of activity. With regard to the IPR, it was examined whether an agreement had been reached on the use or transfer of IPR in different Readiness Scenarios. The relationship between performance barrier and intellectual property rights was assessed.

The authors conducted risk assessment based on a general risk management method, in which the risks are first identified, then their severity is identified, and then it is decided how the identified risks can be affected.[138] Figure 2 denotes the risk framework opted for this study. The risks were grouped on the basis of force majeure and different acts of intellectual property law. In identifying risks based on the environment formed by the agreement, the law and the Readiness Scenario, the factors that influence the formation of the risk were analyzed. As a result of the analysis of the agreements, risk frameworks were drawn up from the perspective of the use of AM. The probability of risk was assessed based on a legal expert assessment. The criterion for assessing probability was the likelihood that a breach of that law could give rise to legal action in court. The

[138] ISO, *Risk management. Guidelines 31000:2018*, 2nd edn., International Organization for Standardization, ISO, 2018.

severity of the risks was assessed on the basis of the effects that a breach of the law may have. The impact of the risks was assessed on the basis of a European Union study on the main risks associated with commercial contracts. There are five types of risks: Organizational/societal, Financial, Market, Technological and others. In each of these circumstances, these risks were assessed on the basis of the factors in the contracts in relation to the circumstances.[139] The other risks were seen as military ones.

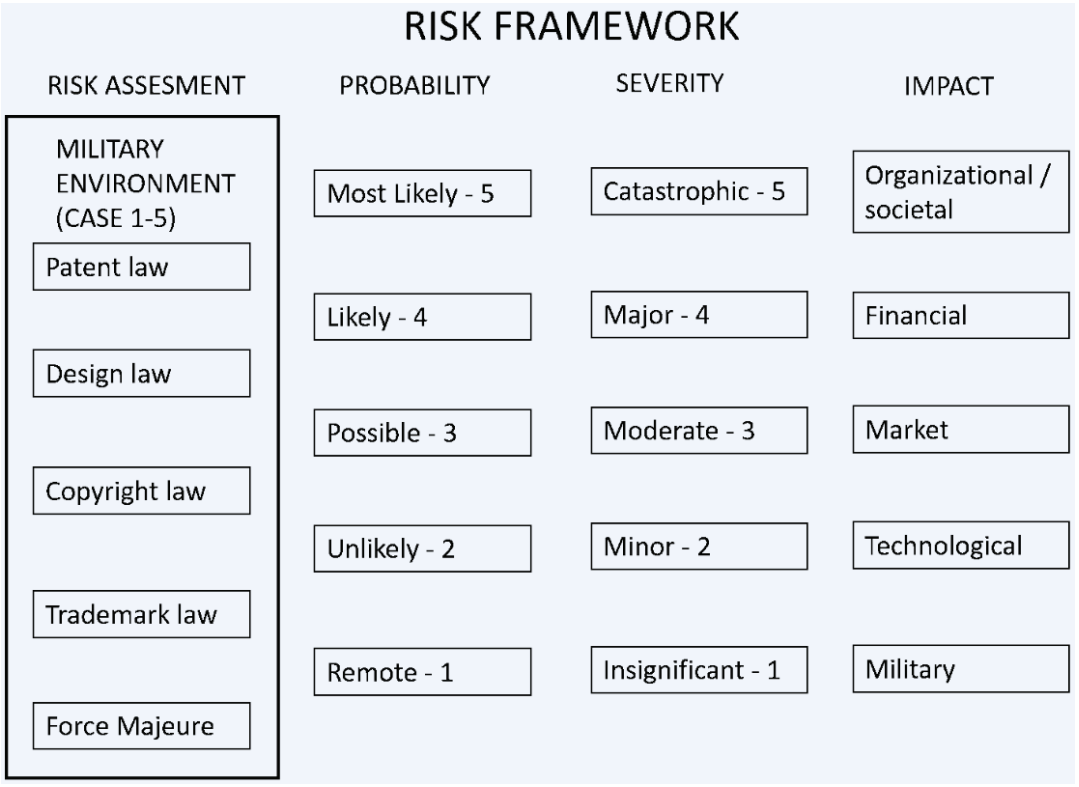
Figure 1. The process of evaluating military procurement contracts for deploying AM.



Source: Own elaboration.

[139] European Commission, *Risk management in the procurement of innovation*, Brussels, European Commission, 2010.

Figure 2. Risk framework.



Source: Own elaboration.

The credibility of the study was confirmed by the triangular measurement[140] of various sources of information, such as interviews, contracts, and secondary sources such as laws and regulations. In this way, it was ensured that the findings of the study were consistent with the case being investigated. The generalizability and transferability of the findings of the study are limited to cases with a similar environment to that of this study. Confirmability is achieved through careful selection of material and by ensuring that interviewees are correctly selected and their findings support the conclusions.

[140] Schwenzer, 'Force Majeure and Hardship in International Sales Contracts'.

Contract Selection and Sampling

The main material of the study was procurement contracts of the Finnish Defence Forces. Out of the 4,792 contracts found in the contract system of the Defence Forces, relevant contracts were classified in three different phases. In the first phase the contracts which were classified as confidential in accordance with the Publicity Act were eliminated[141] (Finlex, 1999). The contracts that were of a non-intellectual property nature were excluded in the second phase. These contracts were for example access restrictions. The Defence Forces area use agreements and rental agreements. In the third phase, the contracts were divided into contracts for the Army, the Navy, the Air Force, and all. There were different numbers of material contracts in different branches of defence. Subsequently, the contracts were divided according to the following criteria:

- According to NATO logistics Classes of Supply – classes I Items of subsistence, II Supplies for which allowances are established by tables of organization and equipment, IV Supplies for which initial issue allowances are not prescribed by approved issue tables and V Ammunition, explosives and chemical agents of all types. (NATO, 2012)
- Different contract models that were Purchasing, Frame contract, Amendment agreement, Software license agreement, Co-operation agreement, Product support contract, Maintenance contract, Technical assistance agreement, Immaterial property rights agreement

The contracts were randomly selected to meet the criteria above. The final material consisted of 31 procurement contracts. The contracts were divided according to the table presented in Annex A and were evaluated according to Figure 1.

In the Finnish Defence Forces, the Head Quarters control contract activities. The logistics department is responsible for the IPR of the contracts and their interpretation. Two people from the Defence Forces Hear Quarters Logistics Department were interviewed to determine the factors related to the IPR of the Defence Forces. One interviewed person is in charge of intellectual property and the other is in the legal preparation of contracts. The interview was conducted as a semi-structured interview, which aimed to clarify the Head Quarters view of the current state of contracts legal factors.

[141] Finlex, *Julkisuuslaki*, 1999.

In the interview, the interviewees were asked about military material product warranty, the validity of intellectual property rights in various environmental situations, legal interpretations of rights, and the conclusion of a force majeure in procurement contracts. The interviewees were also asked which factors they saw as the most influential in the AM processes.

The interviews were used to support the results of the contract analysis. The material of the interviews was used to discover whether the content of the agreements corresponds to the Finnish Defence Forces view of the matter. The findings of the interviews about legal issues were classified using the same taxonomy as in the classification of contracts. In this way, the main factors influencing the use of the new technology could be identified.

Results

AM is a relatively new manufacturing method which makes it difficult to consider in existing contracts for the supply of long-life military material. On the basis of the findings, it was discovered that the in-house and outsourced production do not appear in the contracts. On this basis, it was identified that the existing agreements do not provide the contractual approval of OEMs for using AM to produce parts or components of the performance under the agreements.

The agreements interpreted the circumstances in which an OEM should, from a legal point of view, waive its rights to manufacture the material. Under Finnish and European Union legislation, IPR are independent of the circumstances. There are separate acts of legislation that can be reclaimed by regulation, but they do not directly remove the protection of intellectual property rights. Therefore, it was identified that, there is no circumstance which would legally require an OEM to waive its rights to copies. On the other hand, it should be noted that European Union law does not restrict the aftermarket of goods, which means that not all copies enjoy the same protection of IPR.

Under different circumstances, coercion looks different. In a crisis situation, the force majeure of products is loosely defined. Therefore, the delivery barrier may be interpreted differently in different situations. As a general rule, a military conflict in which the party acquiring the material is a member of the conflict cannot be considered an obstacle to the supply of military material. Legally, the matter is interpretative, and therefore poses a risk. In conditions of war, Finnish legislation follows Western jurisprudence and enables the compulsory acquisition of industrial property rights by the

state. This reduces the risk. However, the challenge is that the spectrum of material is very wide, which is why the number of patents to be filed and the perception of patents contained in the materials do not allow the patents contained in the individual components to be taken.

The parts of the agreements concerning IPR and mandatory regulations are very similar. Consequently, it can be concluded that there is no clear and detailed agreement in the contracts for the maintenance or repair of the performances in such a way that parts could be produced without OEM approval under any circumstances. It is essential that, from a legal point of view, the owner of an intellectual property right is entitled to compensation. From the point of view of AM, this means that the use of the method poses a legal risk that can be considered by risk management methods.

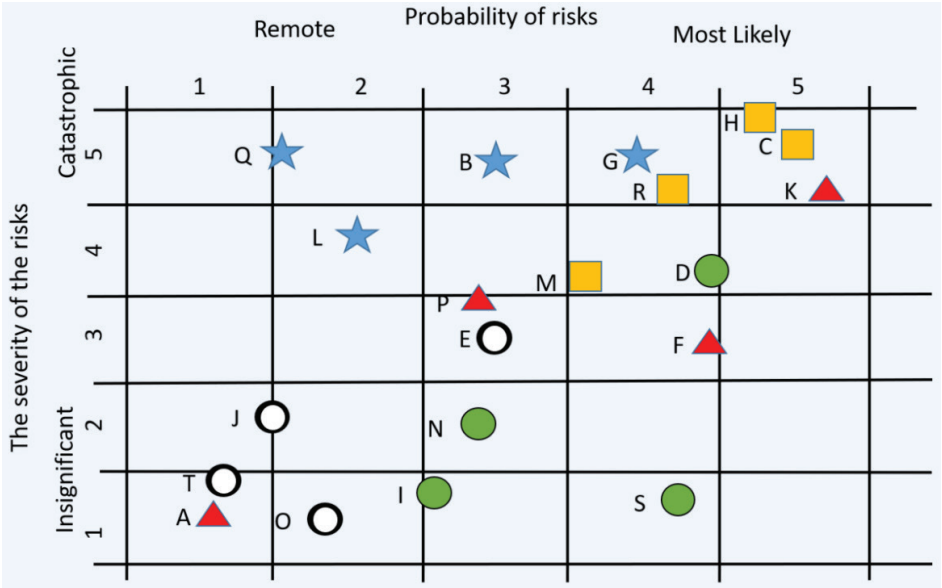
With regard to intellectual property laws, the effect of different laws is different in different circumstances. Based on the interpretation of the agreements, the impact of different laws was assessed in the risk framework. The risk framework was used to identify which laws are violated, particularly for the deployment of AM in different conditions. Figure 3 depicts the severity and probability of risks for each contract as a function of Readiness Scenarios.

In Figure 3, the highest risk is indicated by the letter H. This risk arises in a crisis situation for design law, as the legislation on exceptional circumstances does not apply, the need for material has increased with the crisis and there is no time to start contract negotiations. Redesigning the shape protected by the design law delays the manufacturing of the product and direct modelling tools such as laser scanning cannot be used as such. In the figure, the lowest risk is indicated by the letter A. This risk consists of a force majeure situation under normal circumstances. An insurmountable obstacle under normal circumstances consists of an exceptional situation in which it is not justified to hold a party liable for contractual breaches resulting from the obstacle. Therefore, the risk of manufacturing in breach of contract can be considered very low, as manufacturing can be considered legitimate.

The probability in Figure 3 is an estimate of how likely a law or significant contractual instrument is likely to be subject to legal action in that scenario. High risk means that it is very likely that the law or part of the contract will affect the use of the AM method. Low risk means that legally there is no such probability. Severity refers to the assessment of the effects of such legal action in a different scenario. An insignificant effect means

that the effect of the legal action is small. The catastrophic effect implies an overall significance for the use of AM as well as significant and difficult problems in all areas of risk in case the residual risk is chosen to be tolerated.

Figure 3. Severity and probability of risks that different laws affect in different Readiness Scenarios.



CRITERIA	PEACE TIME	CRISES	WAR	HOST NATION SUPPORT
Force Majeure ▲	A	F	K	P
Patent Law ★	B	G	L	Q
Design Law ■	C	H	M	R
Copyright Law ●	D	I	N	S
Trademark Law ○	E	J	O	T

Source: Own elaboration.

Figure 3 shows that the impact of different laws must be considered separately for each law. The economic effects of the use of AM from the point of view of IPR are the most significant. This is putting upward pressure on the price of already accelerating military materiel. By considering the legal implications of the technology associated with the new material to be procured at the acquisition stage, their cost impact can be reduced.

After the award of the contract and for pre-existing material, pricing may be unpredictable. On the other hand, it was identified that the direct or indirect effects of other effects could not be underestimated.

Based on expert interviews, the importance of trademark law was less than that of other intellectual property laws. This supports a result based on the interpretation of treaties about the effects of different laws. With regard to the effect of the trademark law, it matters whether the military brand is seen to have value. Manufacturers brands can also have value as trademarks. One example of this is fighters. In 2019 in Japan, an F35 fighter fell to the ground and caused the manufacturer to instruct all fighters of the same brand to remain on the ground until the cause of the fall was determined. This led to the trademark value of the F35 fighters.

From a risk management perspective, it is essential to identify what can be done about the risk. The risk can be accepted or efforts can be made to reduce its effects. The key element of reducing legal risks is contracting. Another possible means is the enforcement of IPR permitted by the legislation on exceptional circumstances. However, this requires preparation. In exceptional circumstances, the key benefit of AM is rapid manufacturing, which is why taking advantage of the possibilities of emergency legislation requires that the acquisition of IPR must be well prepared under normal circumstances.

Discussion

Based on the results, the use of AM has not been considered in the buyer-supplier contracts of the Finnish Defence Forces. Therefore, the interpretation of the contract and the interpretation of a possible breach of the contract remain subject to force majeure. Nor does force majeure remove IPR, which means that some risk of using the method in exceptional circumstances must be accepted if the agreement or licensing cannot or will not be concluded. The potential for self-manufacturing or manufacturing through a third party introduced by AM may necessitate a more detailed examination of the definition of force majeure.

The results indicate that contracts for critical components which satisfy the economic and technical specifications for AM should be renegotiated for existing contracts and negotiated for new contracts in a manner that considers the digital characteristics, i.e., CAD models for manufacturing, digital inventories, rapid manufacturing close to the point of need without part-specific tooling, etc., to comply with the IPR of the suppliers of military materiel. This can allow the defence forces to yield the benefits of

AM, particularly the avoidance of obsolescence caused by long life cycles, through a non-infringeable deployment in the military logistics.

Table 2, which is a combination of the results in Figure 3, discusses the impact of assessed risks pertinent to a breach of intellectual property law. It is possible to reduce the legal risks identified as a result of the study. Legal risks under normal circumstances and in a crisis are mainly financial.

Carrying out financial risks under normal circumstances is typically unprofitable. To reduce the risk, rights can be purchased or risk-taking could lead to lengthy and difficult legal action. Both cases could lead to a reduction in the supply of physical materiel, while state defence budgets remain within their limits. In exceptional circumstances, financial risk-taking is worthwhile and is therefore not relevant to the use of the method.

Organizational risks can affect at different levels. Small countries often have to settle for the materiel that is offered to them. For this reason, it is also important to safeguard their reputation as a good contracting partner. Countries with a strong military industry of their own may have very different opportunities to agree on IPR. The political dimension can affect access to military equipment, with the procurement of military equipment often being regulated not only by countries themselves but also their unions. Uncontrolled use of AM can therefore affect cross-border and OEM-user relationships.

From a military point of view, the most significant market effects are reflected in the security of supply. How self-sufficient a military force is able to operate, or how self-reliably a state can produce the products needed by a military force, depends on the security of supply. With regard to legal factors, the use of AM may affect the market and may create or limit new business opportunities in the maintenance of military material.

When looking at the use of AM in the security industry, it can be concluded that dynamic AM delivery increases the security of supply in the security industry and helps maintain the performance to prepare for various crises. However, AM's digital capabilities, such as CAD models of parts, electronic warehousing, automated manufacturing, require encryption and security measures to prevent, for example, unintentional intrusion by security-threatening intruders and manipulation of digital models. Such preventive security measures have already been demonstrated using blockchain technology to achieve data authenticity. Overall the materiel acquisition process especially in the security and defence industry where material lifecycle is relatively long and products could be used in different circumstances will face similar challenges when using AM. It is important

to note that safety-related situations, which typically require rapid material preparation, occur in a variety of ways. Material preparedness for such situations is difficult, making AM well placed to manage disruptions and difficulties caused by natural disasters or deliberate human actions.

The use of AM from a technological point of view can affect the development of equipment and systems. On the one hand, it can improve and speed up development work, but on the other hand, it can lead to more technologically secure systems. This can make it difficult to repair systems and tie users more tightly to the supplier. Instead of applying for patents, the technology can be protected by encryption. This increases technology dependency and makes AM use more difficult, especially for small states.

Other effects were also identified in the risk assessment. In particular, the importance of acting as a contractual partner is of military importance. This also requires knowledge of the AM method in drafting contracts. In addition, risk management requires preparedness. In terms of preparedness, it is essential to identify the use of the method in different applications. This can serve as a powerful negotiation tactic for the selection of optimal suppliers that may enhance the overall capability by introducing a breachless deployment of AM for neutralization of a potential threat.

The interviews revealed that intellectual property rights and their management are challenging. The suppliers of military material and the material to be procured are different in each case. Therefore, it is challenging to create comprehensive guidelines for contracts. The possibilities and effects of new technology on the agreement must also be considered in terms of how the agreements can enable the most efficient use of the technology.

Currently, the use of AM is regulated or restricted in several military forces because there is no certainty as to how the laws will be interpreted in the event of a disputed use. The fact that, for the first time in industrial history, AM has enabled the user to manufacture products without intermediate steps has posed challenges to legislation and existing contract structures. The method can change the use and maintenance of existing material. It is in everyone's interest that the legislation on use is clear and allows for the use of technology.

The effect of the circumstances is twofold. On one hand, it affects preparedness, and on the other hand, the action itself. Risk management is one of the key ways to prepare for an undesirable or harmful situation. In particular, factors that have not been prepared for can cause significant damage to the protected object. The impact of new technology on operations can

be unpredictable. From a legal point of view, it means that the impact of different laws on the use of technology must be considered as a whole, but still understanding the specific features of technology. The nature of activities and the environment is examined through existing law. The agreements drawn up will be interpreted in relation to existing legislation. On this basis, it was identified that, in addition to legal dogmatics, theories influencing research are theories of risk management and military operations.

This study aids logistics decision-makers, logistics personnel, and personnel working on security and defence industry in establishing and corroborating the legal aspects that should be considered for an appropriate deployment of AM. Considering the exceptional circumstances of equipment shortage caused by COVID-19, the model developed in the study can also be applicable to several different sectors of security.

Table 2. Impact of risks pertinent to breach of intellectual property law by the Finnish Defence Forces

Impact	Organization/Societal	Financial
Trademark Law	Low – No Organizational risks.	Intermediate – the financial impact can be high if printing suffers someone's brand.
Copyright Law	Low – at most a minor risk to the reputation management of the organization.	Intermediate – if the "work" threshold is exceeded. It is unclear when a CAD model is considered work.
Patent Law	High – reputation management in an organization can cause problems. Credibility problems.	High – significant economic impact.
Design Law	Intermediate – a risk to an organization's reputation management.	Intermediate – crossing the threshold is unclear. Changing the shape can cause its aesthetic features to change, so that the law is no longer valid.
Force Majeure	High – reputation management risk.	High – significant economic impact.

Appendix A

Table 3 Contracts

Contract area	Branch	Class of Supply	Contract model
Weapons	Army	II	Purchase
Aviation	Army	II	Frame contract
ICT	Logistics	II	Frame contract
ICT	Logistics	II	Amendment agreement
Logistic support	All	II	Purchase
Aviation	Army	II	Amendment agreement
Software	All	IV	Software license agreement
Aviation	Airforce	II	Purchase
Weapons	Army	V	Co-operation
Software	Airforce	IV	Software license agreement
Logistic support	Airforce	II	Frame contract
Spare parts	Airforce	II	Purchase
Surveillance	Army	II	Product Support Contract
Logistic support	Army	II	Frame contract
Services	All	IV	Frame contract
Logistic support	Navy	II	Maintenance contract
Aviation	Airforce	II	Maintenance contract
Logistic support	All	II	Frame contract
Construction material	Airforce	IV	Purchase
Logistic support	All	II	Purchase
ICT	All	II	Purchase and maintenance
Services	Airforce	IV	Technical assistance

Contract area	Branch	Class of Supply	Contract model
Services	Airforce	IV	Maintenance contract
Spare parts	Airforce	II	Purchase and support
Spare parts	Airforce	II	Maintenance
Construction	Airforce	IV	Immaterial property rights
Aviation	Airforce	II	Purchase
Services	Airforce	IV	Purchase
Logistic support	All	II	Purchase
Tools	All	II	Technical arrangement
Weapon	Army	II	Purchase

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