

# Application of Operations Research in Defence and Military Supply Chain & Field Logistics: A Review

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**Abstract**—Defence logistics must send supplies to moving units on time. Transport is limited. The budget is fixed. An enemy can destroy vehicles and depots. This paper reviews sixteen studies on how Operations Research can help with this problem. Each study looks at one stage of the defence supply chain. These stages go from budget allocation and base location to weapon-target assignment, tactical distribution, battlefield inventory and deployment scheduling. The studies were grouped into four technique families: assignment and Integer Programming, location-allocation, network routing and distribution and scheduling and Simulation. Each study was compared on the problem it addressed the technique used the decision variables, objectives and constraints the results and the limitations. Three patterns emerged. Military objectives are different from ones. They give weight to exposure to attack, lateness and destroyed target value than just cost. Realistic models become too large, for methods. Therefore heuristics, decomposition and learning-based methods are common. Many models assume fixed, conditions and are tested on hypothetical scenarios. The main gap is the lack of models that link these decisions under battlefield uncertainty and adversarial behaviour.

**Index Terms**—Operations Research, Military Logistics, Integer Programming, Facility Location, Network Routing, Weapon-Target Assignment, Simulation, Markov Decision Process

## I. Introduction: Operations Research in Defence & Military Supply Chain and Field Logistics

Modern military operations and field logistics are one of the most complex resource-allocation and decision-making environments, where each mistake results in mission failure, timely support, and many lives lost. Operating under extremely challenging battlefield conditions, limited time windows, and multiple logistical constraints, a military commander cannot rely solely on instinct or pre-war planning. They must apply Operations Research to develop a set of optimization frameworks that consider routing, inventory, resource deployment, and numerous other variables.

This project aims to showcase papers and research that apply various quantitative methods and mathematical models, from Risk-Aware Shortest-Path Optimization [16], Column Generation [13], or Markov Decision Processes [7, 12] to Binary Integer Programming [8], Discrete-Event Simulation [5, 9], and Facility Location Theory [6, 11], to address military logistics and defense industry-related tasks. From tactical supply distribution [13], garrison resupply [12], weapon-target allocation [7, 8, 10], and FOB logistics [4, 14], to military capital asset planning [2, 3] – OR has proven to be instrumental in finding operationally optimal and economically feasible solutions in defense-related fields.

This report will focus on quantitative approaches to defense and military logistics, specifically on supply chains and field operations. The topic is of particular interest to us due to its complexity and unique optimization characteristics that take into account many variables not involved in commercial operations. Defense logistics is usually about survival, rapid response, and critical support, which makes it fundamentally different from most supply chain problems we have encountered in class. At the same time, studying such operations allows gaining valuable insight into how military operations are planning and executed at the cutting edge.

Examining papers submitted by our classmates for this class gives us a perspective of how different optimization questions arise in military logistics, what modeling approaches (including linear programming ones) are used to solve them, and what considerations are made when deployed in real-world scenarios. The topics covered in our classmates' papers are truly fascinating to us, as they demonstrate the enormous scope of operations research in defense and military operations fields. Studying them helps understand how different mathematical models and quantitative approaches form the basis of many modern-day military operations.

## II. Literature Review

### Paper-by-paper summaries

#### ***Sub-topic 1: Military Supply Transportation & Forward Depot Distribution (Varsha S)***

Varshney (2020) [16] builds a war-simulation framework for India defending eight frontiers simultaneously. It combines risk-aware shortest-path routing, which penalises threatened or blocked roads, with a digital supply-chain twin that tracks the battlefield in real time, and an adapted PERT estimate of how many allied reinforcements will actually arrive. Across ten runs, average frontiers defended rose from 5.2 to 7.8 and delivery time fell from 7.8 to 5.3 turns.

Rogers et al. (2018) [9] present MLNPS, a proof-of-concept planning tool for the US Army's global supply network, which handles about 50,000 requisitions a day. The network is treated as a 'virtual factory' in which requisitions are jobs and depots and transport modes are machines. A goal-seeking discrete-event simulation with revised-slack priorities minimises maximum lateness and exposes queues and bottlenecks for planners to fix. This paper was analysed under both sub-topics 1 and 6.

Sebbah, Ghanmi & Boukhtouta (2011) [13] model Canadian Forces distribution of mixed commodities from main to forward operating bases using trucks and tactical helicopters. The problem combines vehicle routing and bin packing, and is solved by column generation, which adds promising routes to the model only when they improve it. A simulation module then shows how tighter lead-times and unsafe roads raise support cost and change the best fleet mix. This paper was analysed under both sub-topics 1 and 6.

#### ***Sub-topic 2: Troop, Equipment & Weapon-Target Assignment (Pari Chitkara)***

Li, Li, Deng, Li & Cheng (2026) [8] propose a bidding-collaborative model for weapon-target assignment against an integrated air-defence system. Each brigade solves its own binary program to bid for strike tasks, respecting ammunition, range, dwell time and an 80% damage-probability requirement. Command then selects one bid per target at minimum total cost. Solved in Gurobi, instances grew from about 2 seconds for 10 targets to about 248 seconds for 100 targets.

Roux & van Vuuren (2007) [10] review threat evaluation and weapon assignment (TEWA) decision support for ground-based air defence. The paper explains how threats are ranked by intent and capability, and how weapons are then assigned to threats. It notes that weapon assignment is NP-complete, so exact methods are limited, and that threat evaluation is hard to formalise because it depends on judging enemy intent. It is a foundational map of the field.

Li, He, Xu, Zhao, Song & Li (2023) [7] reformulate dynamic weapon-target assignment as a Markov decision process and solve it with RL4WTA, a multi-head deep Q-network. Separate network heads choose targets for each weapon, and a masking mechanism blocks actions that break constraints. The trained model produced satisfactory assignments for both small and large scenarios much faster than traditional optimisation, although without a guarantee of optimality and only after costly training.

#### ***Sub-topic 3: Defence Budget Allocation & Base Location Planning (Musharraf Rehaman)***

Brown, Coulter & Washburn (1994) [2] review HEAVY ATTACK, the US Air Force's theatre-level model used since 1965 to load weapons onto aircraft and assign sorties to targets. An early linear version produced extreme all-or-nothing plans, so the model became nonlinear to capture diminishing returns from

repeated strikes. Solved period by period, it guided about \$2 billion of munitions purchases in 1988, with \$5.2 billion planned for 1994–99.

Sadigov, Guliyev & Sabziev (2021) [11] locate a military logistics centre on a road network so that annual transport cost to a supply terminal and several units is minimised. This is a Weber-type location problem restricted to permitted road sections. The authors prove that the cost function is concave along each section, so the optimum always lies at a section endpoint. The search therefore reduces to evaluating and ranking a small set of nodes.

Brown, Dell & Newman (2004) [3] show how US military procurement, worth about a trillion dollars, is planned using a succession of integer programs. The base model is a binary knapsack: choose the projects that maximise military value within the budget. It is extended with purchase quantities, separate budget categories ('colours of money'), dependencies between systems and multi-year horizons. Two case studies illustrate modelling tricks that keep these large models solvable.

#### ***Sub-topic 4: Tactical Inventory & Battlefield Supply under Constraints (Saidharan Sunketa)***

Gue (1999) [4] develops a multi-period, multi-commodity mixed-integer program for US Marine Corps sea-based logistics. In each period it decides which land support points are open, how much each stores, and how supplies flow from ships to combat units within air and ship-to-shore lift capacity, minimising inventory ashore. For a 600-Marine unit, it showed the sea base could not be 75 nautical miles offshore unless the operational plan was resequenced.

Toyoglu, Karasan & Kara (2011) [14] design a three-layer ammunition distribution network on the battlefield. Their location-routing model chooses fixed and mobile transfer points and truck routes for several ammunition types, within hard time windows, minimising either cost or driving time (to reduce convoy visibility). Valid inequalities tighten the formulation, and corps-sized cases with 20 battalions reached optimality gaps below 10% within 24 hours.

Salgado (2018) [12] models resupply of forward operating bases by unmanned cargo aircraft that may be shot down as a Markov decision process with stochastic demand. To overcome the huge state space, he proves that the value function increases with inventory and builds a monotone approximate dynamic programming algorithm (MLSTD). It reached a 3.05% optimality gap and beat standard LSTD by 31.86% on average, while routing heuristics beat a myopic policy by 22%.

#### ***Sub-topic 5: Infrastructure Deployment & Military Base Construction (Thaijhasa Satish Prasanthi)***

Vafaeinejad et al. (2020) [15] extend the vector assignment ordered median problem with facility capacity (VAOCMP) to locate fire stations in Tehran with a 5-minute response target, solving it in GIS with tabu search and simulated annealing. Adding capacity raised unserved demand from 52,840 to 59,080, showing that existing stations were insufficient. At least three new stations were needed, and tabu search performed better than simulated annealing.

Karatas, Yakıcı & Razi (2019) [6] survey facility location models used by military organisations, including munitions depots, sensor networks, UAV bases and search-and-rescue units. They classify studies by core model (p-median, p-centre, maximal covering and set covering) and by solution approach, from integer programming to metaheuristics. They highlight gaps such as dynamic, multi-objective and uncertain military location problems.

Azzolini Junior et al. (2023) [1] optimise the layout of departments in a shipyard to minimise material-handling cost while respecting closeness requirements. A sequential structure of algorithms is used: a genetic algorithm first places departments on a topological grid, a stochastic growth algorithm then fits their exact shapes, and the ELECTRE multi-criteria method with local search fine-tunes the result. It is relevant to laying out military bases and shipyards.

### **Sub-topic 6: Mission Execution Timelines & Emergency Logistics Crashing (Kripa Bedi)**

Hodgson, Melendez, Thoney & Trainor (2004) [5] present the Deployment Scheduling Analysis Tool (DSAT) for moving military units and equipment through air, rail and sea ports. Deployment is treated as a job-shop scheduling problem that minimises maximum lateness. DSAT builds equipment routings, repeatedly simulates the deployment, and uses a heuristic to reassign transport assets, allowing planners to test scenarios and reduce closure time.

*Note: Rogers et al. [9] and Sebbah et al. [13] were also analysed by Kripa Bedi under sub-topic 6, alongside Hodgson et al. [5].*

### **Synthesis and Research Gap**

We notice that across the sixteen studies the problems were different but the same limits kept showing up. Assignment and capital planning models decided how to give out weapons and budgets [2, 3, 7, 8, 10]. Location models chose where to put facilities [1, 6, 11, 15]. Routing and inventory models moved supplies [4, 12, 13, 14, 16]. Scheduling and simulation models followed delay [5, 9]. Most made the real situation simpler so that the problem could be solved. Several assumed that demand was fixed that speeds were fixed or that material flows were fixed [1, 4, 15]. Others ignored enemy action or the changes that happen on a battlefield. The size of the problem was a barrier. Therefore heuristics and approximations were used of exact solutions in many cases. Some models also needed real-time data, which a battlefield may not give [9, 16]. Others required assumptions such as discount rates to be set beforehand [3].

Few studies linked their decision to the stages before or after it. Budget, location, distribution, assignment and scheduling were each modelled separately. This leaves a gap for models that connect these decisions and remain strong when faced with uncertainty and enemy action. The analysis, in Section 4 looks at how each technique family fills this gap.

### **III. Methodology**

This study uses a literature review method to look at how Operations Research (OR) tools are used in defence and military supply chains and field logistics. It looks at research papers that the group studied, covering topics like resource allocation, facility location, inventory management, transportation, routing, scheduling and tactical logistics distribution.

The studies that were chosen were looked at based on how relevant they were to logistics and how they used clear OR techniques. Papers that dealt with civilian uses were also looked at if their methods gave helpful ideas about logistics planning and resource allocation. However their results were looked at in the context of the uses they were designed for.

A standard set of rules was used to compare the studies. These rules included the problem they looked at the OR technique they used the goal and limits of the model, how it was used in life the benefits it brought and the limits it had. The review also told the difference between optimization, heuristic methods, dynamic programming and simulation-based ways to understand how each method helps with different logistics decisions.

The results were put into themes to find similarities, differences and trade-offs between the studies. Special attention was given to cost efficiency, delivery time, availability of resources, capacity limits and uncertainty. The comparison also looked at problems like how hard it's to calculate how reliable the data is and the limits of the assumptions, in the models.

This method gives a way to understand how different OR techniques can help with military logistics decisions and shows chances to make coordination, efficiency and reliability better across connected supply chains.

## IV. Analysis

### Assignment and Integer Programming

Assignment and Integer Programming are techniques in Operations Research (OR). These methods help organizations make the decisions when resources are limited. Their importance shows up in the four research reports. Each report uses these techniques in ways. The applications include planning, resource allocation, facility location and logistics.

Assignment Problems focus on matching resources to tasks in an efficient way. In the report titled A Bidding-Collaborative Model for Weapon-Target Assignment against Integrated Defence Systems [8] assignment models are used to find the weapon-target combinations. These models look at target priorities, what weapons can do, costs and time limits. In reports assignment problems show up in transportation, resource distribution and facility location. These are about making assignments that work well under constraints.

Integer Programming is used when the decisions must be numbers. For example you can't buy half a truck. Assign 0.7 of a person to a job. Binary programming is a type of integer programming. It uses 0 and 1 to show choices like yes or no. The military capital-planning report [3] uses linear integer programming. It helps pick which equipment to buy with a budget. The goal is to get the military capability. The logistics report [4] uses mixed-integer programming. It plans how to send supplies over time. It also takes into account how much each vehicle can carry. Facility location models use integer programming too [6, 15]. They decide where to place facilities based on cost and capacity.

These techniques matter because they solve problems. Problems that involve resources, budget limits, transportation limits and real-world rules. They help make the use of what is available. They cut costs. They help organizations make choices. That makes assignment and integer programming useful tools. They are especially important, in operations and industries that need to manage many resources efficiently.

### Location-Allocation Models

Four of the reviewed papers looked at where to place a facility so that cost, distance or response time stayed low. Sadigov et al. (2021) [11] Located a military logistics centre using the Weber problem. They limited the centre to road sections and showed the cost function was concave in that area. This meant the lowest cost always occurred at an endpoint of a section. Only endpoints had to be checked which kept the search process fast. The model focused on transportation cost and assumed yearly costs did not change.

Vafaeinejad et al. [15] Extended an ordered median location model into VAOMP. They set a cap of 50,000 people per fire station to avoid overloading any one station. Tabu search and simulated annealing were used to find sites quickly within minutes. The model assumed fixed driving speeds did not consider real-time traffic and gave near- solutions instead of exact ones.

Karatas et al. [6] Reviewed military facility location problems. They discussed p-median models (which minimise total distance) p-center models (which minimise the distance) maximal covering and set covering models. These were solved using integer programming and heuristics like simulated annealing. As a survey it showed that the best model depended on the goal. It also pointed out that these models used fixed settings and became slow when dealing with maps.

Azzolini Junior et al. [1] Focused on layout than site selection. They placed shipyard departments in a way that reduced material travel. A genetic algorithm selected the neighbourhood for each department then a growth algorithm shaped its form. The method reached layouts in about a hundred search steps compared to over three thousand steps if done the traditional way. It assumed material flows were fixed and did not change.

The main difference among the four papers was the solving method. Sadigov et al. [11] Used a method suitable, for small single-site problems. The others used heuristics to handle capacity constraints and larger maps. All four assumed static conditions, which limits their usefulness in a battlefield that changes rapidly.

### **Network, Routing and Distribution Models**

Network, distribution, and routing models optimize how military equipments, supplies, and tactical assets traverse complex operational spaces under strict capacity, time, and risk constraints. One of the major methodology is risk-aware shortest-path optimization [16], which efficiently calculates dynamic transit routes by factoring in adversarial threats, blocked pathways, and shifting hazard levels rather than relying solely on geographical distance.

At the tactical sustainment level, distribution models include concepts like the Capacitated Vehicle Routing Problem (CVRP) for route optimization with the Bin Packing Problem (BPP) for physical cargo allocation inside transport assets like tactical helicopters logistics trucks and tactical helicopters. Because combining routing and loading creates massive algorithmic complexity, column generation algorithms are employed to effectively and efficiently breakdown large-scale mixed-integer programs into manageable subproblems, enabling efficient management of heterogeneous fleets [13].

Furthermore, facility location models address strategic asset placement. Specialised techniques such as the classical Weber problem [11] minimize yearly transportation costs for logistics centers by evaluating the real distance between roads and restricted road sections. Advanced spatial frameworks—including the Vector Assignment Ordered Median Problem (VAOMP) [15], p-median, Maximal Covering Location Problem (MCLP), and p-center [6]—further optimize the positioning of critical infrastructure like UAV bases, fire stations, and supply depots under tight budget and coverage constraints. Additionally, geographic information systems (GIS) seamlessly weave these intrinsic location-allocation models with spatial data to ensure rapid response times and comprehensive coverage across expanding regional operational boundaries [15]. Additionally, the multi-objective optimization techniques give way to the decision-makers to evaluate complex trade-offs between minimizing transit lead times and controlling overall support expenditures across multi-modal transport networks [13].

### **Linear Programming, Scheduling and Simulation**

Linear programming, scheduling, and simulation provide structured mathematical and computational frameworks to manage complex resource allocation involved in the field of defence where timing sequences and operational bottlenecks are under severe uncertainty.

Job-shop scheduling and discrete-event simulation form the backbone of large-scale deployment frameworks such as the Military Logistics Network Planning System (MLNPS) [9] and Deployment Scheduling Analysis Tool (DSAT) [5]. These advanced systems model global military supply chains as an N-job / M-machine job problem, where individual supply claims act as "jobs" and transport nodes, ports, or warehouses act as "machines" dedicated to minimizing maximum closure time and lateness. Goal-seeking discrete-event simulations systematically track these claims step-by-step through every single layer of the intrinsic logistics network, utilizing queue metrics and revised slack heuristics to detect critical choke points and guide dynamic capacity adjustments before backlogs cascade across operational theaters [9].

Complementing simulation, mathematical programming rightly optimizes resource selection, weapon targeting, and capital distribution. Binary and integer programming models—such as the binary knapsack problem utilized in long-term military capital planning [3] and rigorous assignment models for weapon-target allocation [7, 8, 10]—maximize overall operational capability under strict budget ceilings, non-mixable funding pots, and capability quotas. Moreover, nonlinear objective functions and diminishing-returns logic are frequently integrated into these programming models to prevent unrealistic over-allocation and account for the repeated-strike value of assets [2].

Finally, adapted PERT uncertainty modeling estimates expected reinforcement quantities and arrival schedules under hostile adversarial interference [16]. This dynamic capability allows digital supply chain twins and real-time control layers to continuously update tactical timelines as battlefield conditions shift, bridging the gap between rigid pre-war planning and unpredictable combat realities.

### Comparative discussion

Studies show that Operations Research plays a role in solving many challenges faced in defence and military logistics. Each Operations Research method serves a purpose. Assignment and integer programming help decide how limited resources should be distributed. Location-allocation models help find places for military facilities and supply centres. Routing models show how supplies can be moved efficiently. Scheduling and simulation help planners identify delays and spot problems that may affect the movement of supplies.

A key difference between these Operations Research methods is how they deal with problems. Mathematical optimisation finds solutions based on the objectives and constraints set in the model. However, when a problem involves resources, routes and restrictions, finding a solution can become difficult and time-consuming. In such cases, techniques such as heuristics and column generation can simplify the process [5, 13]. Although these techniques make problem-solving more practical, they do not always guarantee the best possible outcome.

Another important difference is how each Operations Research method handles uncertainty. Some optimisation models work well when demand, capacity and operating conditions stay fairly stable. However, military logistics rarely follows a completely fixed plan. Supplies may be delayed, demand may change, and transport resources may become unavailable. Dynamic programming and simulation help planners understand these situations and examine how different decisions might affect the operation [9, 12, 16]. However, the results are only as reliable as the data and assumptions used in the models.

The studies also make it clear that solving one problem does not necessarily solve the entire logistics challenge. For example, adding more vehicles may not improve delivery times if supplies are already delayed at a warehouse [9]. Similarly, choosing a location for a facility may lead to higher transportation costs later. This means that decisions about facilities, inventory, transportation and scheduling need to be considered together to achieve better results.

There is also a balance between cost, speed and reliability. Faster transportation can help supplies reach their destination sooner, but it can also increase costs [13]. Keeping additional inventory can reduce the risk of shortages, although it requires more storage space and money. The right decision therefore depends on the urgency of the mission, the resources available and the conditions in which the logistics system operates.

Overall, the comparison suggests that combining Operations Research methods could help make military logistics more efficient and reliable. Instead of looking at each problem separately, future research could focus on approaches that connect transportation, inventory, scheduling and resource allocation. These approaches could also account for changing demands and unexpected disruptions. Improving the quality of data and testing models under realistic conditions would further help bridge the gap between mathematical solutions and their practical use in military logistics.

Table 1: Comparison table of all 16 papers

| S.No. | Authors, Year & Paper Title                                                                                                                                                                                                | Source / Publication Venue                                               | Core Operations Research (OR) Technique Applied                                                                                   |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1     | <b>Varshney, A. N.</b><br>A Dynamic Operations Research Framework for Military Logistics and Resource Allocation Under Uncertainty: A War Simulation Case Study [16]                                                       | Indian Institute of Management Amritsar                                  | Risk-Aware Shortest Path Optimization, Digital Supply Chain Twin (DSCT), Adapted PERT Uncertainty Modeling                        |
| 2     | <b>Rogers, M. B., McConnell, B. M., Hodgson, T. J., Kay, M. G., King, R. E., Parlier, G., &amp; Thoney-Barletta, K.</b><br>A Military Logistics Network Planning System [9]                                                | North Carolina State University (GCSS-Army ERP app)                      | Goal-Seeking Deterministic Discrete Event Simulation, Job-Shop Scheduling Analogy, Slack Heuristics                               |
| 3     | <b>Sebbah, S., Ghanmi, A., &amp; Boukhtouta, A.</b><br>Modelling and Simulation of Military Tactical Logistics Distribution [13]                                                                                           | Defence R&D Canada (Canadian Forces)                                     | Column Generation (CG) Algorithm, Capacitated Vehicle Routing Problem (CVRP), Bin Packing Problem (BPP)                           |
| 4     | <b>Vafaeinejad, A., Bolouri, S., Alesheikh, A. A., Panahi, M., &amp; Lee, C.-W.</b><br>The Capacitated Location-Allocation Problem Using the VAOMP (Vector Assignment Ordered Median Problem) Unified Approach in GIS [15] | Geospatial Information System (GIS) Applications                         | Vector Assignment Ordered Median Problem (VAOMP), Tabu Search, Simulated Annealing                                                |
| 5     | <b>Karatas, M., Yakıcı, E., &amp; Razi, N.</b><br>Military Facility Location Problems: A Brief Survey [6]                                                                                                                  | Academic Survey on Military Asset Positioning                            | p-Median (minisum), p-Center (minimax), Maximal Covering Location Problem (MCLP), Set Covering Problem (SCP), Integer Programming |
| 6     | <b>Azzolini Junior, W., Azzolini, F. G. P., Mundim, L. R., Porto, A. J. V., &amp; Sadati Amani, H. J.</b><br>Shipyards facility layout optimization through the implementation of a sequential structure of algorithms [1] | Industrial Engineering & Facility Layout Studies                         | Spatial Layout Planning, Genetic Algorithm, Growth Algorithm                                                                      |
| 7     | <b>Salgado, E. L. (2018)</b><br>The Military Inventory Routing Problem [12]                                                                                                                                                | Air Force Institute of Technology (Dissertation: AFIT-ENS-PhD-18-DS-042) | Markov Decision Process (MDP), Approximate Dynamic Programming (ADP), Monotone Least Squares Temporal Difference (MLSTD)          |
| 8     | <b>Gue, K. R. (1999)</b><br>A Dynamic Distribution Model for Combat Logistics [4]                                                                                                                                          | Naval Postgraduate School (Report: NPS-SM-99-003)                        | Multi-Period, Multi-Item Mixed-Integer Programming (MIP)                                                                          |
| 9     | <b>Toyoglu, H., Karasan, O. E., &amp; Kara, B. Y. (2011)</b><br>Distribution Network Design on the Battlefield [14]                                                                                                        | Naval Research Logistics, Vol. 58, pp. 188–209                           | Three-Stage Location Routing Problem (LRP), Mixed-Integer Programming (MIP), Valid Inequalities                                   |

| S.No. | Authors, Year & Paper Title                                                                                                                                                              | Source / Publication Venue                                 | Core Operations Research (OR) Technique Applied                                                     |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 10    | <b>Li, X., Li, Y., Deng, Y., Li, J., &amp; Cheng, G.</b><br>A Bidding-Collaborative Model for Weapon-Target Assignment against Integrated Defence Systems [8]                            | Combat Decision Systems Research                           | Binary/Integer Programming, Assignment Optimization, Bidding-Collaborative Fire Strike (BCFS) Model |
| 11    | <b>Roux, J. N., &amp; van Vuuren, J. H.</b><br>Threat Evaluation and Weapon Assignment Decision Support: A Review of the State of the Art [10]                                           | Ground Based Air Defense Systems (GBADS) Review            | Optimization Theory, Resource Allocation, Assignment Theory                                         |
| 12    | <b>Li, S., He, X., Xu, X., Zhao, T., Song, C., &amp; Li, J.</b><br>Weapon-Target Assignment Strategy in Joint Combat Decision-Making Based on Multi-Head Deep Reinforcement Learning [7] | Joint Combat Decision-Making Literature (RL4WTA framework) | Markov Decision Process (MDP), Deep Q-Network (DQN), Reinforcement Learning                         |
| 13    | <b>Brown, G. G., Coulter, D. M., &amp; Washburn, A. R. (1994)</b><br>Sortie Optimization and Munitions Planning [2]                                                                      | Military Operations Research, Summer 1994                  | Linear & Nonlinear Programming (HEAVY ATTACK Model & SELECTOR)                                      |
| 14    | <b>Sadigov, A. B., Guliyev, B. A., &amp; Sabziev, E. N. (2021)</b><br>The Problem of Optimal Location of the Military Logistics Center [11]                                              | Informatics and Control Problems, 2021                     | Weber Problem, Facility Location Theory, Concave Function Optimization                              |
| 15    | <b>Brown, G. G., Dell, R. F., &amp; Newman, A. M. (2004)</b><br>Optimizing Military Capital Planning [3]                                                                                 | Interfaces, 2004                                           | Binary Knapsack Problem, Integer Linear Programming, Multi-Year Budget Allocation                   |
| 16    | <b>Hodgson, T. J., et al.</b><br>The Deployment Scheduling Analysis Tool (DSAT) [5]                                                                                                      | Deployment & Transport Scheduling Frameworks               | Job-Shop Scheduling, Heuristics, Discrete-Event Simulation                                          |

## V. Conclusion

### Key findings

The analysis of research papers shows that Operations Research (OR) is very important for defence logistics and military supply chain management. The review looks at studies on resource allocation, military capital planning, facility location, weapon-target assignment, transportation, inventory management, scheduling and tactical distribution. These studies show how different Operations Research (OR) techniques can help military organisations make decisions even when budgets are tight, transport capacity is limited, time is short and battlefield situations are unpredictable. Assignment and Integer Programming, location-allocation models, network routing, scheduling and simulation emerge as approaches for addressing these challenges. A key finding is that military logistics needs more than cutting costs because decision makers must also think about delivery delays, danger from enemy attacks, resource availability and mission needs. The comparison also shows that different techniques have purposes and choosing the right method depends on the kind of problem the resources available and the goals of the operation.

### Benefits

Operations Research helps defence logistics use resources better and make decisions based on data. Operations Research lets planners assign tasks to the people and machines so that every resource gets the job it is best suited for. Operations Research uses Integer Programming to pick the military equipment when

money is limited because Integer Programming deals with items that cannot be split into smaller parts [3]. Operations Research finds the sites for bases and supply centres with Location-allocation models cutting travel costs and making supplies easier to reach [6, 11]. Operations Research also maps out the efficient routes for trucks taking into account how many goods a vehicle can carry when deliveries must happen and what risks exist [13, 14, 16]. Operations Research helps planners spot delays. Choke points with Scheduling and Simulation and it shows how a single disruption can ripple through the whole supply chain [5, 9]. Advanced Operations Research tools—such as heuristics, column generation, dynamic programming and simulation—tackle hard problems that regular optimisation cannot solve [5, 12, 13]. These Operations Research benefits matter a lot in war, where good use of resources, delivery and reliable operations can decide a mission. Operations Research is not perfect. Complex mathematical models can take a long time to run especially when there are many variables and rules. Heuristics get solutions faster. They do not always give the best result. Operations Research also needs data; if the numbers or assumptions do not match reality the decisions may fail. Models that assume fixed demand, speeds or capacities may not keep up when the battlefield changes quickly. So while Operations Research can be very useful its real power comes from choosing the model having trustworthy information and staying flexible when conditions shift.

### Drawbacks

Despite these advantages the review points out research gaps. Many existing models look at decisions, such as resource allocation, facility location, transportation and scheduling separately instead of combining them into one whole system. Moreover several models do not fully account for battlefield conditions changing demand, enemy attacks and unexpected disruptions. Future research should focus on creating integrated models that mix different Operations Research techniques, use real-time information when possible and are tested under realistic battlefield scenarios to make military logistics more efficient and reliable.

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