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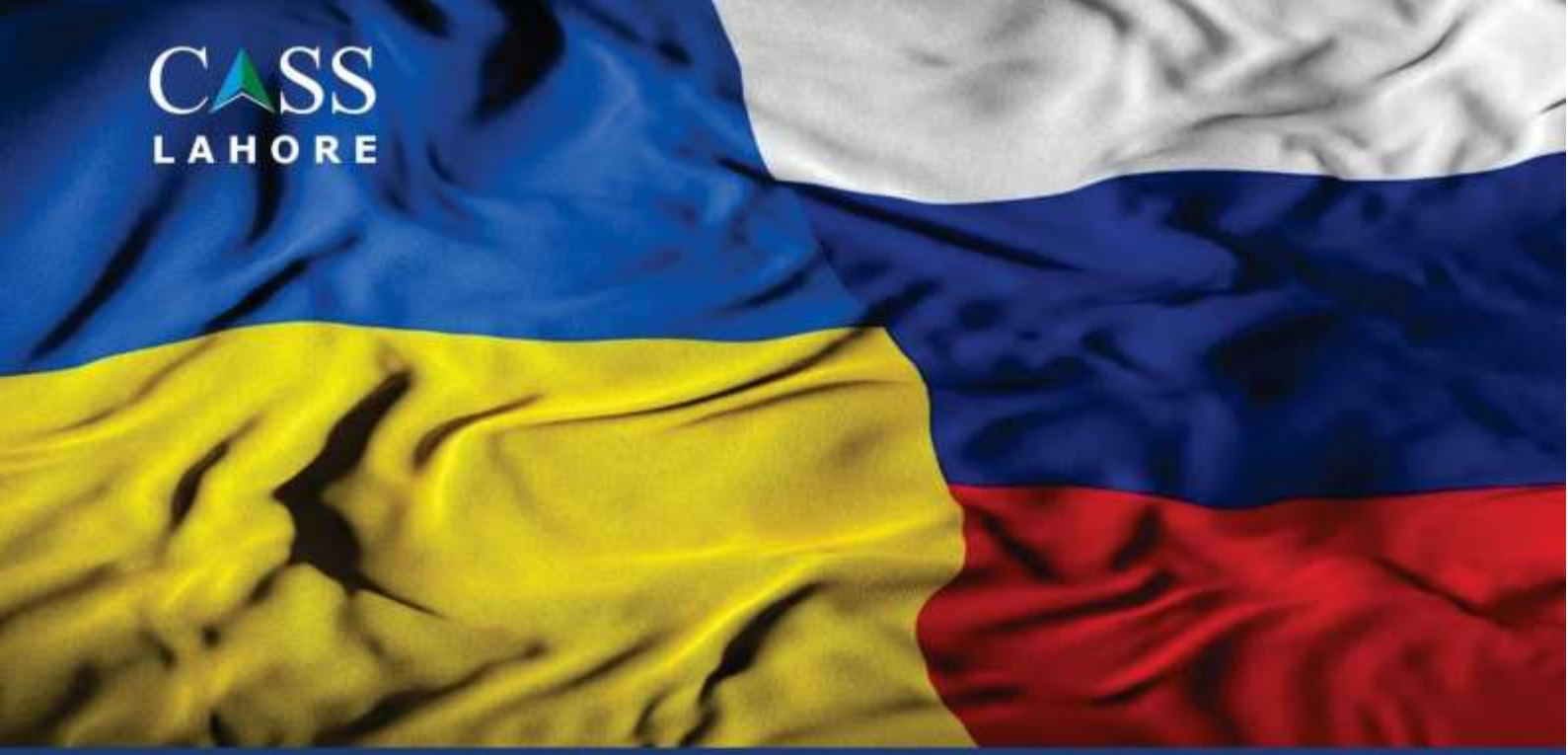
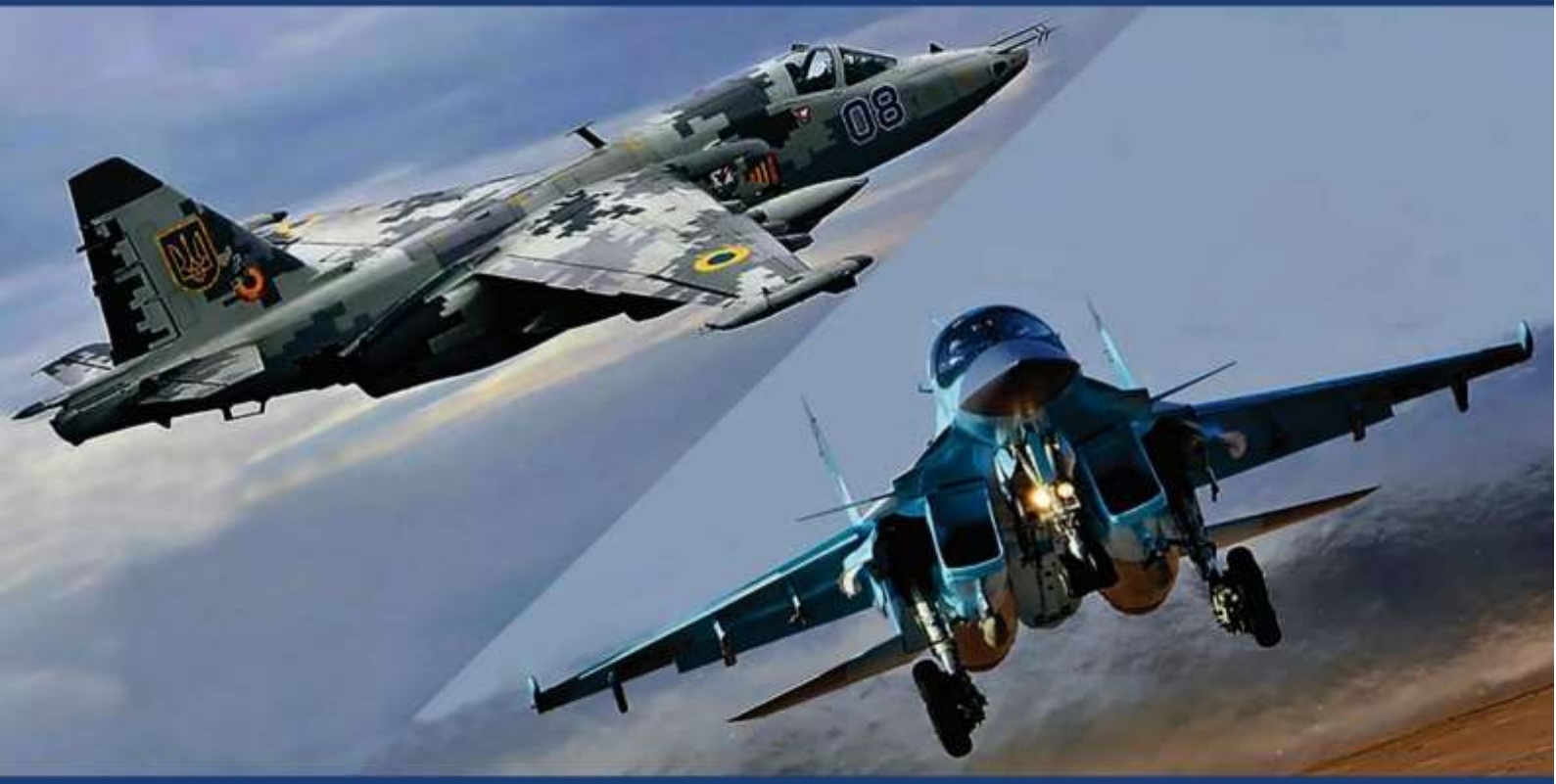


EMPLOYMENT OF AIRPOWER IN RUSSIA-UKRAINE CONFLICT: LESSONS FOR AIRPOWER



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Abstract

The employment of airpower has become instrumental in changing the outcomes of the war since the previous decades. A proper utilisation of airpower has resulted in quick gains for many states. Likewise, in Russia-Ukraine conflict, the employment of air power is crucial and given that it is a recent conflict, it yields critical lessons for the effective utilisation of airpower and reveals the gaps in such utilisation of air assets in modern warfare. This research paper aims to evaluate the employment of airpower in Russia Ukraine conflict on strategic level. Highlighting the Russian Air Force, the paper delves into their diverse assets and explores inherent strengths and weaknesses, and correspondingly undertaking a comprehensive assessment of the Ukrainian Air Force to highlight their assets and limitations. This study then compares the air power of both nations, and reveals the nuanced interplay of offensive and defensive strategies of both airpowers. Integral to the analysis is the role of allied support in bolstering Ukrainian air power and domain capabilities. By dissecting gains and losses for both sides, the study underscores the tangible impact of air power. The study distils invaluable lessons applicable to air power worldwide, encompassing technology, tactics, command, training, intelligence, surveillance, and joint operations. These insights hold implications for the Pakistan Air Force, guiding future readiness and capability enhancement. Ultimately, it contributes to a comprehensive framework for effective air power utilisation, refining strategic approaches and tactical implementations.

Keywords: Russia-Ukraine Conflict, Russian Airpower, Ukrainian Airpower, Airpower Employment, Airpower Lessons, Pakistan Air Force

Introduction

Air power has become a primary asset in determining the course of the war over the past decades. Airpower has significance in various aspects of military operations which has played role in changing the whole dynamics of wars since the previous century. For instance, during the Soviet invasion in Afghanistan, where the loss of air superiority contributed to the Russians' failure, and Operation Desert Storm, which showcased the success of air power in achieving air superiority and dominating the outcome of the conflict.[1] In these modern wars, airpower has played a critical role in achieving unity of effort in special operations and the world witnessed the revolutionising role of Unmanned Aircraft Systems (UAS) as they offered strategic advantages and intelligence, surveillance, and reconnaissance (ISR) capabilities. These wars have proved the airpower's versatility, strategic impact, and potential for integration which make it indispensable in addressing complex security challenges in the 21st century.[2]

The success of air power in the Gulf War led to the concept of Revolution in Military Affairs (RMA), suggesting that air power would dominate future wars.[3] Air power's main task is to achieve and maintain control of the air and space, securing comparative advantages for joint forces. Once air supremacy is established, air power performs various supporting missions, including humanitarian aid, transport duties, Close Air Support (CAS), and Combat Search and Rescue (CSAR). [4] Airpower's effectiveness in modern warfare stems from its attributes: speed, range, height, and ubiquity. These traits allow for swift action, long-range force projection [5] , flexibility, and persistent intelligence gathering. Enhanced precision reduces collateral damage[6], while roles like Defensive and Offensive Counter Air, information warfare, and ground support underscore its significance. [7] Air supremacy remains crucial for joint-force victory on today's battlefield. [8]

Given that airpower plays a major role in modern wars, the assessment of employment of airpower in Russia-Ukraine Conflict is suggestive of the strengths and weaknesses of the employment strategy and assets of both states. In the Russia-Ukraine airpower along with

[1] Dobrowolski, Tobias. "Is Air Power Essential to Winning a Modern War?." *German Air Force Academy*, April 2013.
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Robbin Laird, "The Role of Airpower in 21st Century Operations," *Second Line of Defense*, April 10, 2013, .
[6] Ibid.
[7] Ibid.
[8] Ibid.

other elements has been integrated to achieve desired military objectives. In February 2022, Russia launched a full-scale invasion of Ukraine and conducted a special operation with the integration of its air forces and ground forces aiming to seize Kyiv and other major cities, but faced strong resistance and counter-attacks from Ukrainian forces. [9] Russia conducted significant military build-up along Ukraine's borders, and in response to Western rejection of demands, declared Luhansk and Donetsk as independent republics and invaded Ukrainian territory. The initial goal was to establish a pro-Russian government in Kyiv, with forces advancing on multiple fronts. Given the large airpower of Russia, the world predicted a blistering assault by Russia against Ukraine that would quickly mobilise the big Russian air power. However, after facing setbacks, Russia was forced to shift its focus to eastern and southern Ukraine and withdraw from the north.[10] See Annexure (A) for illustration.

The Russian Air Force

1) Overview of Russian Air Force Assets

Russia's defence budget for 2021 was $48.5 billion USD or 3.58 trillion Russian Rubles and which increased significantly to $66.9 billion USD or 4.68 trillion Russian Rubles in 2022, indicating a substantial boost in military spending.[11] In 2023, the military budget has been $61.5 billion USD or 4.98 trillion Russian Rubles.[12] In 2015, Russia merged its Russian Air Force (VVS) and Russian Aerospace Defence Force (VVKO) to form the Russian Aerospace Force (VKS). The Russian Air Force maintains an impressive active personnel count of 165,000 and has 1,500,000 reservists across all branches.[13]

At the heart of Russia's military power lies its Strategic Rocket Force of 50,000 personnels. This force comprises several Intercontinental Ballistic Missile (ICBM) regiments equipped with a variety of advanced systems, including the RS-12M Topol, RS-12M2 Topol-M, RS-18, RS-18 with Avangard Hypersonic Glide Vehicle (HGV), RS-20, RS-24 Yars, and the Yars-S variant. These sophisticated ICBMs, some equipped with hypersonic technology, indicate Russia's capability to strike targets with precision and effectiveness.

The Long-Range Aviation Command serves as another pillar of Russia's air power, responsible for operating the nation's strategic bomber forces. With squadrons comprising the iconic Tu-160 Blackjack, the versatile Tu-95MS Bear H, and their respective modified variants, Russia

[9] Ibid.
[10] David Brown, "Ukraine Invasion: Russia's Attack in Maps," *BBC News*, February 24, 2022, sec. Europe.
[11] International Institute for Strategic Studies, *The Military Balance 2023*, 1st ed. (Routledge, 2023).
[12] Ibid.
[13] Ibid.

possesses a potent means of strategic projection. [14] These long-range bombers have the capacity to carry nuclear-tipped cruise missiles, providing Russia with the ability to reach far-flung targets and exert its influence on a global scale.[15]

The Aerospace Defense Command plays a pivotal role in ensuring the protection of its airspace and assets. Armed with cutting-edge air defence systems, Russia posses Long-Range SAM Systems (HIMADS) which include S-300PS (RS-SA-10B Grumble): 160 units, S-300PM1/PM2 (RS-SA-20 Gargoyle): 150 units, S-300V (RS-SA-12 Gladiator/Giant): 20 units, S-400 (RS-SA-21 Growler): 248 units and Medium-Range SAM System (LOMADS): 9K37M1-2 Buk-M1-2/9K317 Buk-M2 (RS-SA-11 Gadfly/RS-SA-17 Grizzly): 80 units and Short-Range SAM System (SHORADS) 96K6 Pantsir-S1/S2 (RS-SA-22 Greyhound): 50 units.[16] The Russian transportation capability encompasses a diverse fleet of aircraft, including An-12BK Cub, An-148-100E, An-26 Curl, Tu-134 Crusty, Tu-154 Careless, and Mi-8 Hip. It also features strategic transport with An-124 Condor and Il-76MD Candid, showcasing their heavy airlift capability. Moreover, their versatile aviation capabilities extend to combat and utility helicopters like Ka-52A Hokum B, Mi-28N Havoc B, Mi-35 Hind, Mi-26 Halo, and Mi-8MTV.

The VKS employs short, medium, and long-range AAMs, including the unique R-37M with a range exceeding 300km, ensuring air superiority. The VKS has short range AAMs like R-73 and R-60T with range of 30kms, and 7kms. Medium range AAMs like variety of R-27 with ranges up to 80kms and R-77-1 with range 80kms. The long range AAMs include R-33S of range 160kms, and newly inducted a unique R-37M with range exceeding 300kms. [17]

The precision-guided munitions are used for various air-to-ground strike missions and have the capability to be guided by inertial navigation systems (INS), GLONASS (Global Navigation Satellite System), laser designation, or TV guidance. Russia possesses a range of PGMs such as INS/GLONASS-guided bombs: KAB-500S with range 40kms, Laser-guided bombs: KAB-500L and KAB-1500L with range 30kms, and TV-guided bombs: Ghaem-5 with range 50kms, KAB-500KR and KAB-1500KR with ranges 15-17kms and new UPAB 1500 with range of 50kms.[18]

[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.
[18] Ibid.

Russia has a variety of Uninhabited Aerial Vehicles with long ranges of more than 250kms and long endurance of 20 to 30 hours like Inokhodets, Medium Forpost R and Mohajer 6 which play role in ground attack, CAS, ISR, and have unmanned capability. Russian air doctrine calls for cutting off and destroy enemy forces and for this purpose, Russia have electronic-warfare units such as R-330Zh Zhitel which can jam GPS signal within 30kms.[19] Moreover their aircraft also possess the capability of air-borne jamming.[20]

Moreover, the Russian Air Force maintains an extensive inventory of aircraft, satellites, and unmanned aerial vehicles (UAVs) designed to fulfil various roles and missions. From advanced fighter aircraft fleet of 1,511 [21] aircrafts like the MiG-29, Su-35, and Su-57, to the capable ground attack platforms such as the Su-25 and Su-34, Russia's Air Force is equipped with a diverse fleet to tackle a wide array of challenges.[22] Additionally, strategic bombers like the Tu-22M3, Tu-95MS, and Tu-160, along with aerial refuelling tankers, transport aircraft, and attack helicopters, further demonstrate Russia's comprehensive approach to aerial dominance.[23] Refer to Annexure (B) for complete data on Russia airpower assets.

2) Strengths and Weaknesses

Strengths:

- The Russian Air Force has a significant number of active personnel, which indicates a robust operational capability.
- It has a diverse inventory of modern aircraft which enhances its precision strike capabilities like Su-35S, Su-30SM, Su-34, and a fifth generation multirole fighter Su-57 Felon.
- Its aircrafts are equipped for day and night precisions strikes and multirole missions with a good standoff range from 100 to over 300km[24] such as the Tu-22M3,Tu-95MS, Tu-160, Su-35S, Su-30M, Su-34.
- Russian fleet is highly updated as 75% of these aircraft are new or modernised.[25]
- It has an advanced radar systems offering extensive tracking and targeting ranges, even in the presence of ground clutter such as Bars-M radar, IRBIS-E radar which have

[19] Tom Porter, "Russia Is Jamming 'Sophisticated' US Weapons Being Used in Ukraine, Making Them Useless, Report Says," *Business Insider*, accessed August 8, 2023.
[20] David Brown, "Ukraine Invasion: Russia's Attack in Maps," *BBC News*, February 24, 2022, sec. Europe.
[21] "Why Hasn't Russia Mobilised Its Vast Air Power against Ukraine?," www.aljazeera.com, March 2022.
[22] Ibid.
[23] Ibid.
[24] David Brown, "Ukraine Invasion: Russia's Attack in Maps," *BBC News*, February 24, 2022, sec. Europe.
[25] Sebastien Roblin, "Russia's Modernized Air Force Is More Capable—Here's What It's Procuring Next," *Forbes*.

tracking range of up to 350kms ad targeting range of 250kms. [26] Russian exceptional Shmel radar (A-50/A-50U Mainstay) has the capable of detecting a missile launch at 1000kms and can provide 40 targets at once for interceptors. This advanced radar system significantly enhances Russia's situational awareness and responsiveness in complex operational scenarios, making it a vital asset in their strategic defence and offense capabilities.

- Moreover, Russia possess cruise missiles of long ranges enables the engagement of targets deep within opponent territory such as Kh-31, Kh-58, Kh-59, Kh-101, and Kh-555 which ranges varies from 2500 to 35kms. [27]
- The availability of PGMs with various guidance systems (INS, GLONASS, laser, TV) enhances accuracy in air-to-ground strike missions.
- The presence of UAVs with long ranges and endurance, such as Inokhodets, Medium Forpost R, and Mohajer 6, contributes to ground attack, ISR, and unmanned capabilities.
- The electronic warfare capabilities of Russia are very effective as it possesses electronic-warfare units like the R-330Zh Zhitel, capable of jamming GPS signals, along with airborne jamming capabilities.
- The force demonstrates the ability to employ long-range precision strike capabilities, including cruise missiles, ballistic missiles, and air-launched quasi-ballistic missiles. These systems can strike targets at great distances with accuracy.
- With a substantial number of surface-to-air missile systems like the S-300, S-400, and Buk-M1, the Russian Air Force has a robust and high tech air defence network.[28]

Weaknesses:

- Despite combat experience gained in Syria, VKS primarily operates in small formations, thus limiting the practical experience of planning and coordinating extensive air operations.[29]
- Russian pilots have not been exposed to large formation tactics and have limited live flying training hours, which hinders their ability to perform in complex and contested environments.[30]

[26] Michael Peck, "Russian Fighter Jets Are Struggling in Ukraine, but Ukraine Can't Beat Their Missiles and Radars, Researchers Say," *Business Insider*.
[27] David Brown, "Ukraine Invasion: Russia's Attack in Maps," *BBC News*, February 24, 2022, sec. Europe.
[28] Ibid.
[29] Justin Bronke, "Is the Russian Air Force Actually Incapable of Complex Air Operations?," *RUSI*, 2022.

- It is believed that Russian pilots were not trained for complex air operations and their live flying time during training was approximately 100 to 120, compared to NATO pilots who train for 180 to 200 hours annually.[31] The limited flying hours for VKS pilots hinder advanced tactical training, leading to potential inefficiency in complex air operations.
- Russian Air Force primary threats against NATO nations are through long-range strategic aviation (LRA) and cruise missiles, which are less capable in direct air-to-air engagements.[32]
- It has been said that Russian forces have morale issues because the soldiers are mostly deployed into the battlefield with little training, no clear instructions, and poor equipment. Many of them are conscripts who are inducted on ad hoc bases without a proper training.[33]

Ukrainian Air Force

1) Overview of Ukrainian Air Force Assets

The budgetary allocation for defence increased significantly in 2023, reaching 30.6 billion USD. [34] Ukraine's air power assets are relatively modest, with a small number of combat-capable aircraft and helicopters, and limited air defence systems. Ukraine has approximately 79 combat-capable aircraft, comprising 50 fighters (MiG-29 Fulcrum and Su-27 Flanker B), 20 attack aircraft (Su-24M Fencer D and Su-25 Frogfoot), and 9 reconnaissance aircraft (Su-24MR Fencer E).[35] Additionally, the Ukrainian Air Force operates a small number of transport aircraft and helicopters, mainly comprised of Soviet-era models like the An-24, An-26, Il-76, and Mi-8 Hip.[36] Its AAMs such as air to air missiles R-27, R-60, R-73, SARH R-27R, R-27ER are short to medium range missiles with ranges from 80 to 130kms.[37]

Regarding air defence systems, Ukraine possesses a relatively sizeable number of surface-to-air missiles (SAMs), with a significant number of long-range S-300PS/PT and medium-range 9K37M Buk-M1 systems. The inclusion of NASAMS (Norwegian Advanced Surface-to-Air Missile System), a short- to medium-range ground-based air defence system, suggests that

[30] Ibid.
[31] Ibid.
[32] Ibid.
[33] Jennifer Mathers, "Russia Is Depending on Its Soldiers for Victory in Ukraine but They Have to Bring Their Own First Aid Kits—and 200,000 Are Probably Already Dead," *Fortune*, 2023.
[34] International Institute for Strategic Studies, *The Military Balance 2023*, 1st ed. (Routledge, 2023).
[35] Ibid.
[36] Ibid.
[37] Ibid.

Ukraine has invested in modernizing its air defence capabilities with Western-made systems.[38] However, the overall air defence network might be limited in terms of geographical coverage and modern capabilities compared to larger military powers. Refer to Annexure (C) for complete data on Ukrainian airpower assets.

2) Strengths and Weaknesses

Strengths

- The Ukrainian Air Force possesses a reasonable number of surface-to-air missile systems like the S-300 and Buk-M1, which contribute to its air defence capabilities.[39]
- The Ukrainian Air Force has access to UAVs like the Bayraktar TB2, which can provide valuable intelligence, surveillance, and reconnaissance (ISR) capabilities.
- The inclusion of Western-made systems like the NASAMS indicates that Ukraine is investing in the modernisation of its air defence capabilities. [40]

Weaknesses

- Until 2023, Ukraine's defence budget had been relatively low compared to some of its potential adversaries. While the budget increased significantly in 2023, it might still be insufficient to support comprehensive modernization and expansion efforts required to keep up with larger military powers.
- The majority of Ukraine's combat aircraft and helicopters are Soviet-era models, which may face challenges in terms of technological obsolescence, spare parts availability, and many do not have the capability to perform at night.[41]
- With only around 79 combat-capable aircraft and a small number of helicopters, Ukraine's air force might be numerically outnumbered and face challenges if engaging in a large-scale conflict against a more substantial air force.[42]
- It AAMs have comparatively lower ranges compared to VKS not allowing the force with a similar depth as Russia.[43]
- Ukraine relies on the ISR solely on Su-24MR Fencer E and UAVs such as Tu-141 Strizh. They are speculated to rely on AWACS of US and NATO. [44]

[38] Ibid.
[39] Ibid.
[40] Ibid.
[41] Ibid.
[42] Ibid.
[43] Ibid.
[44] Ibid.

Force Comparison of Russia and Ukraine Air Power

Russia's air force boasts a mix of conventional and high-tech aircraft equipped with advanced avionics, radar systems, and enhanced combat capabilities. These aircraft possess long-range strike potential and electronic warfare systems, giving them a formidable edge in air-to-air and air-to-ground engagements and many are night capable. In contrast, Ukraine relies on older aircraft potentially lacking night capability and other advanced features. Russia's air-launched missile arsenal includes diverse options with long ranges allows them depth, while Ukraine's inventory missiles are mostly short to medium range. Russia's extensive precision-guided munitions range features missiles providing significant strike capabilities, contrasting with Ukraine's more limited precision-guided munitions resources. Russia's robust air defence network, including systems, although surpasses Ukraine's less extensive defence capabilities; however, Ukraine also has a good air defence system in place. With advanced radar systems Russia enhances situational awareness, whereas Ukraine's ISR relies on assets like the Su-24MR Fencer E and UAVs. Overall, Russia holds a clear offensive and defensive advantage due to its advanced aircraft, missile diversity, and robust air defence.

Russia’s Offensive and Defensive Strategy

Russian Air Power Offensive Employment

The Russian Aerospace Forces (VKS) initially conducted strikes against fixed targets in Ukraine, including main ground-based early warning radars throughout Ukraine, airfields, satellite communication facilities, ammunition depots, and control towers.[45] The goal of these strikes was to establish an unchallenged aerial environment for Russia's ground forces by blinding the Ukrainian Air Force. This lead Ukraine vulnerable to raids by air strikes with guided munitions but this did not happen. [46] Russia used over 75 aircraft in its Ukraine invasion despite previously readied 300 aircraft for Ukraine mission within easy zones of main contact zones, however, the aircraft stayed at ground for first four days.[47] The VKS was unable to achieve air superiority. This lack of the presence of fixed winged aircraft allowed the Ukrainian SAM operators to engage with Russian transports and helicopters gunships more conveniently without a fear of immediate retaliation.[48] Moreover, the Ukrainian air force dispersed its aircraft prior to the invasion, so they were not all destroyed in the initial

[45] Ismail Khan, “The Aerial War against Ukraine the First Six Months,” *Russia and Eurasia Studies Programme,* February 2023.
[46] Justin Bronke, “The Mysterious Case of the Missing Russian Air Force,*”RUSI*, 2022.
[47] Phil Stewart and Idrees Ali, “What Happened to Russia’s Air Force? U.S. Officials, Experts Stumped,” *Reuters*, March 2, 2022, sec. Europe.
[48] Ibid.

strikes. Ukrainian ground-based air defence (GBAD) and surface-to-air missile (SAM) systems survived the initial strikes and were able to shoot down Russian aircraft.[49] Russia's air force initially tried to conduct day sorties at low altitudes, but as per Ukraine's claim, this resulted in the loss of at least 10 aircraft. [50] Ukrainian MANPAD crews had difficulty targeting Russian aircraft at night, so Russia shifted its penetration sorties to night attacks which lead to the utilisation of Su-34 which had the technical equipment and training necessary for low-level night operations. Su-34 could deploy GLONASS-guided munitions but they carried out attacks with unguided munitions. This also raised questions for as to why the VKS drew down on the number of PGMs, relying instead on unguided munitions.[51] The use of precision-guided weapons by Russia is observed to be minimal (around 3% of total munitions used) compared to the US/NATO, which heavily relies on precision-guided munitions.[52] These points towards the widely accepted theory that Russia has might have limited PGMs due to years of combat operations in Syria. Consequently, a significant portion of the approximately 300 VKS fixed-wing combat aircraft stationed around Ukraine might rely heavily on unguided bombs and rockets for ground-attack missions.[53]

A possible explanation of the limited use of their fixed winged aircraft can be that VKS might lack confidence in safely coordinating their actions with Russian ground-based Surface-to-Air Missile (SAM) systems operated by the Ground Forces. Concerns over the historical issue of friendly-fire incidents involving SAM units, impacting both Western and Russian air forces in various conflicts, are noted. Successful joint engagement zones that allow combat aircraft and SAM systems to operate simultaneously require tight inter-service collaboration, robust communication, and regular training. Russian forces are criticised for their poor coordination in various areas, including logistics, airborne assaults, and air defence cover for moving columns. [54]

According to analysts, the Russians seemed hesitant to expose their aircraft and pilots to high risks. This wariness might have resulted in a tentative or half-hearted initial engagement in suppression of enemy air defences (SEAD) operations.[55] This restrained approach could be attributed to a variety of factors, including caution to avoid unnecessary losses, desire to

[49] Ibid.
[50] Ibid.
[51] Ibid.
[52] Guy Plopsky, "Analysis of Russian Airpower Deployment in Ukraine by Guy Plopsky," *Hush-Kit*, March 22, 2022, .
[53] Justin Bronke, "The Mysterious Case of the Missing Russian Air Force,"*RUSI*, 2022.
[54] Ibid.
[55] Tara Copp, "Five Reasons Why Russian Forces Are Struggling in Ukraine," *Defense One*, n.d.,

preserve assets, or prioritization of alternative strategies. Moreover, Russia's air force strategy highlights its emphasis on providing air support to ground troops and conducting airstrikes on Ukrainian cities, rather than seeking to establish air superiority. This scenario could be explained in a widely believed theory which says that the traditional tactics employed by continental powers prioritize their land forces.[56] Hence, the absence of aggressive use of new capabilities doesn't necessarily imply technical failure but rather a strategic decision not to employ them extensively.

Moreover, the Russian targeting strategy in Ukraine saw a shift mid battle. Initially, they aimed to pin down Ukrainian air defences by launching ballistic and cruise missile strikes across the country.[57] However, as the conflict progressed, their target list expanded to include Ukrainian military infrastructure, arms shipments from the West, fuel facilities, bridges, and even civilian targets. Even though they targeted various high-value assets, such as operational aircraft, radars, air base facilities, fuel and munitions storage facilities, and runways. [58] However, some strikes were also directed at targets of little value, resulting in inefficiencies which hampered achieving control of air which is one of the vital role of airpower. As the war dragged on, VKS became tied to the tactical challenges faced by the ground forces which minimized the depth of penetration into Ukrainian territory and also gave a setback to the logic of prioritising air targets.[59]

Russia's failure to achieve control of air or air superiority can be attributed to its military doctrine, which limits the autonomy of its Air Force in conducting offensive air campaigns. Unlike more decentralised strategies, Russia's approach restricts the Air Force from pursuing independent air operations.[60] This hampers their ability to coordinate elements for large-scale offensive air efforts necessary to gain control over adversary airspace. Despite initial successful strikes on Ukrainian airfields and defences, Russia's failure to sustain these efforts and incapacitate the adversary's air capabilities reflects their lack of comprehensive control over the airspace. This approach, coupled with attempting swift offensives without

[56] Phillips Payson O'Brien Stringer Edward, "The Overlooked Reason Russia's Invasion Is Floundering," *The Atlantic*, May 9, 2022.
[57] Jacek Siminski, "What the Air Campaign in Ukraine Tells Us about the Current State of the Russian Air Force," *The Aviationist*, March 4, 2022.
[58] Ibid
[59] Ibid.
[60] Diptendu Choudhry, "Russia's Military Understanding of Air Power: Structural & Doctrinal Aspects," www.vifindia.org, May 23, 2022.

establishing sufficient air control, has resulted in higher losses for both the Russian Army and Air Force.[61]

Russian Air Power Defensive Employment

Russia's advanced radar and SAM systems, including the S-300, and S-400 accompanied by patrolling Su-35S and Su-30SM provided an integrated air defence system in close proximity to the battlefield. They have been designed to detect and track low observable (stealth) aircraft like the F-22 and F-35. For airborne early warning & control, it relies on A-50/A-50U Mainstay. To counter Ukraine's counter offensive in East and South, Russia has been using adaptable drones, multi-layered mines, and electronic warfare. [62] They have relocated logistical sites and headquarters to avoid guided rocket and missile attacks. Major air defence systems have been deployed close to the front lines to intercept incoming missiles and drones. Russia's electronic warfare capabilities have played a crucial role, with extensive jamming techniques jamming and disabling of Ukrainian drones, long-range rockets and attack helicopters and even reducing the accuracy of American-guided weapons used by Ukraine.[63] Against Ukrainian offensive on Russia's territory, Russia has employed Pantsir-S, a self-propelled, medium-range surface-to-air missile and anti-aircraft artillery system on government buildings in Moscow and other cities. [64]

Ukraine Offensive and Defensive Strategy

Ukraine Air Defence Response

Ukraine's Air Force had approximately 50 MiG-29 fighters and 32 Su-27 fighters as of February 24, 2022. The Ukrainian medium-range SAM Buk 9K37 system was especially effective against Russian medium- and high-altitude aircraft.[65] According to the Western analysts, Ukraine had one of the densest air defence system in place in whole Europe.[66] It had multiple S-300s which were in operation[67] and these were complemented by the western support in form of MANPADS such as Starstreaks, Stringers, IGLA-S and other SAM and GBAD systems.[68] The dispersion of its air defence assets greatly proved beneficial for

[61] Ibid.
[62] Sophia Ankel, "Why Russia's Defenses Are so Effective: Deep Minefields, Adaptable Drones, and Electronic Warfare Are Proving Formidable in Ukraine, Experts Say.," *Business Insider*.
[63] Ibid.
[64] Robyn Dixon, "Air Defenses Deployed in Moscow, Signaling Fear of Strikes on Capital," *Washington Post*, January 20, 2023.
[65] Ismail Khan, "The Aerial War against Ukraine the First Six Months," *Russia and Eurasia Studies Programme*, February 2023.
[66] Ibid.
[67] "Can the United States Do More for Ukrainian Air Defense?," *CSIS*, 2022.
[68] Ibid.

Ukraine in surviving Russia's initial strikes. Hence, if Ukraine had not prudently dispersed its tactical aviation and maintained its aircraft in field temporarily and repairing them when needed, there was a minimal chance that Ukraine would have survived the initial attack of Russia given the fact that Ukraine remains outnumbered and outmatched by Russia. [69] Ukrainian medium-range SAM Buk 9K37 systems posed a threat to Russian medium- and high-altitude air operations on certain axes.

Ukraine received at least two Patriot missile systems in April 2022, one from the United States and one from Germany[70]. The Patriot interceptor missiles are capable of hitting high- and medium-altitude aircraft, cruise missiles, and some ballistic missiles. It has reportedly hit a Russian Kinzhal missile. While the Patriot system provides enhanced capabilities, it is a stationary system, making it impossible for the Ukrainian military to quickly redeploy it to different areas. This limitation hinders its effectiveness against rapidly changing threats. NASAMS (Norwegian Advanced Surface-to-Air Missile System) which are short to medium range missiles has also proved to be very effective against Russian missiles.[71]

Ukraine Air Power Offensive Employment

In the initial phase, Russia deployed SAMs in multiple locations to shoot down Ukrainian jets. As a result, Ukraine has been cautious in using its fixed-wing fighter aircraft. The Russians were also being cautious, keeping their aircraft outside of Ukraine's territory in the beginning and launching long-range missiles instead. The Ukrainians have relied on drones to attack Russian convoys, and they have effectively used shoulder-fired surface-air missile capability.[72] Ukraine made use of US HIMARS (High Mobility Artillery Rocket System) systems, range of up to 300kms making it world most advanced multiple rocket launchers, when retaking the Kherson and Kharkhiv regions which were responsible for peak Russian causalities.[73] In the counter offensive in the early 2023, Ukraine conducted strikes on Russian military airfield deep inside Russia with drones from within Ukraine's own territory. Ukraine has also conducted strikes on Saki air base in Crimea, and the sinking of the warship Moskva, the flagship of Russia's Black Sea Fleet in its struggle to regain lost territory but it has not

[69] Ibid.
[70] "Ukrainian Air Defenses in Odesa Outgunned as Russia Targets Global Grain Supply," *CNN*, July 20, 2023.
[71] "NASAMS Air Defense System Have 100% Success Rate in Ukraine- Pentagon Chief," *Reuters*, November 16, 2022, sec. Europe.
[72] "Russian Jets Flying 200 Sorties a Day, but Firing from Their Own Airspace, Pentagon Says," *Defense One*, March 2022.
[73] Vikram Mittal, "Military Casualties in Russia-Ukraine War Are Likely Less than Commonly Stated," *Forbes*.

been elaborated whether missiles or rockets were used.[74] The recent inclusion of Hydra-70 rocket system, air-to-ground rockets, from the US will also prove effective against Russia.[75] Moreover, Ukraine has twelve Turkish Bayraktar TB2 drones which were previously used by Azerbaijan against Armenia in 2020. These UAVs have range of up to 300kms, stay in air for 27 hours, and ability to carry four laser-guided munitions and Ukraine has reportedly used them effectively against Russia air defence system mainly in Donbas region.[76]

Allied Support to Ukraine in Airpower Domain

Since the beginning of the war between Russia and Ukraine, the US has sent more than $75 billion in aid to Ukraine between January 24, 2022, and May 31, 2023 which includes humanitarian, financial, and military support.[77] Out of which $46.6B is military aid. Most of the aid goes to Ukraine in form of weapons systems, training, and intelligence. U.S. security assistance in Air power domain between January 20, 2020, and June 27, 2023 includes 1 Patriot air defence battery and munitions, 8 NASAM systems, 1,700 Stinger anti-aircraft systems, 20 Avenger air defence systems, 4,000 TOW missiles, HAWK air defence systems and munitions, 35,000 grenade launchers and small arms with ammunition, Laser-guided rocket systems, RIM-7 missiles, 100,000 sets of body armour and helmets, Anti-aircraft guns and ammunition, thousands of night-vision devices, surveillance systems, laser guided rocket system, 9 anti-drone gun trucks and ammunition, 10 anti-drone laser-guided rocket systems in Air defence. [78] Moreover the US provided Ukraine with ASMs, such as high speed anti-radiation missiles (HARMs), precision aerial munitions, 6,000 Zuni aircraft rockets, and 7,000 Hydra-70 aircraft rockets along with 20 Mi-17 helicopters, explosive and combat drones, surveillance drones, radars and communications, and satellite services. [79]

So, far forty seven countries have provided military aid to Ukraine , however, the US tops the list followed by Germany $8B military aid, UK $7B, Poland $3B, Netherlands $2.7B, AND others amounting to $1B. NATO alliances have restrained from being pulled directly into the war but the many donor government have contributes into the aid by providing Ukraine with modern fighter aircraft.[80] By GDP size of a state, Estonia and Latvia are giving the most to

[74] Vikram Mittal, "Ukraine Is Neutralizing Russian Air Defense Systems ahead of the Counteroffensive," *Forbes*.
[75] Vikram Mittal, "Ukraine Is Neutralizing Russian Air Defense Systems ahead of the Counteroffensive," *Forbes*, accessed July 29, 2023.
[76] Lauren Kahn, "How Ukraine Is Using Drones against Russia," *Council on Foreign Relations*, March 2, 2022.
[77] Jonathan Masters and Will Merrow, "How Much Aid Has the U.S. Sent Ukraine? Here Are Six Charts." (Council on Foreign Relations, July 10, 2023).
[78] Ibid.
[79] Ibid.

Ukraine which mainly constitute military aid. Moreover, in May 2023, the US has announced that it will allow the European countries to provide Ukraine with F-16s that will be effective against Russia's S-300 and S-400 air defence systems. [81] In August 2023, Denmark announced to deliver 19 jets in total with the initial six due around the end of the year, followed by eight in 2024 and five in 2025. Greece will also take part in training the Ukrainian pilots in flying the jets.[82]

As a result of this support, Ukraine successfully protected its territory and launched counter-offensives in key regions like the Donbas, Kharkiv, and Kherson, reclaiming vast stretches of land and liberating towns and villages once under Russian control.[83] A notable achievement in this collective support is the enhancement of Ukraine's air defence capabilities, as they diligently built a three-layered air defence network, integrating advanced Western systems like the U.S.-made Avenger air defence system, short range system vital element of the U.S. Army's Forward Area Air Defense (FAAD) and Line of Sight-Rear (LOS-R) architecture . This strategic move has played a pivotal role in thwarting Russian missile and drone attacks, offering a formidable defence against airborne threats. Moreover the aid in Intelligence, Surveillance, and Reconnaissance (ISR) is also aiding Ukraine to keep track of Russian moves.[84] Refer to Annexure (D) for state-wise allied support.

Political Considerations in Airpower Employment Strategy

The ability to support the political objectives of the state is the true measure of air power. War is always an instrument of policy and air power's success is dependent on bending the enemy's will to align friendly state's interests.[85] Thus, political objectives play a crucial role in air power strategy. Air power is always employed in conjunctions with other forms of diplomatic, military, and economic power in order to achieve the political objectives. However, on the flip side, political limits can also hamper the effective use of the air power. Such as limited wars may restrain the full potential of airpower if its objectives are short of total enemy destruction.[86] Public support and international relations are crucial factors in the employment of air power. While targeting the enemy's will, leaders asses risk of escalation and always aims at keeping the civilian casualties at minimum airpower strategies are also

[81] Ibid.
[82] "How Many F-16 Jets Will Ukraine Get and How Will They Change War?," *Reuters*, August 23, 2023, sec. Aerospace & Defense.
[83] Ibid.
[84] Samuel Charap and Miranda Priebe, "Avoiding a Long War: U.S. Policy and the Trajectory of the Russia-Ukraine Conflict," *RAND*, January 25, 2023.
[85] Bradley J. Smith, "on Politics and Airpower" (U.S. ARMY WAR COLLEGE, 2002).

shaped by the cooperation with allies and coalition dynamics as well as the psychological impact on adversaries and friendly populations must be considered. Ultimately, successful airpower employment requires a delicate balance between broader political objectives and military effectiveness.

Similarly in the context of Russia Ukraine war, analysts in the beginning of the war were of the opinion that political considerations might have influenced Russia's airpower employment strategy.[87] They said one crucial factor for Russia was the need to avoid excessive collateral damage to civilian population. A large pro-Russia population lives in Ukraine and Russia unleashing a full scale offensive air power could have resulted in a civilian loses as it could harm Russia's international image and support for its military offensive.[88] Russia proposed a ceasefire in March 2022, which was seen as an effort to provide the opportunity to civilians to vacate the war zone but the defending forces stated preventing civilian evacuation. Additionally, the analysts were of opinion that Russia refrained from total destruction of Ukrainian airfields and air assets in the initial phase of war to potentially deploy its own airpower in captured airfields, influencing the security concerns of neighbouring NATO member nations.[89] Nevertheless, as the war proceeded, these opinions were rebuked when Russia attacked heavily on civilian infrastructure and other military infrastructure of high value.

Effectiveness and Impact of Air Power in the Russia-Ukraine Conflict

Gains and Losses on Russian Side

Initially, Russia managed to capture southern cities like Melitopol and Mariupol, north-east through the Donbas, and in the north, the province of Kharkiv. Russia managed to capture a total of one fifth of Ukrainian territory, which is 119,000 square kilometres out of total 603,500 square kilometres of Ukraine.[90] This included north part, such as the Chernobyl Exclusion Zone, and a corridor of territory that reached to the edge of Kyiv along with agriculturally-rich Kherson region in the south. However, soon after, it withdrew from north and gave up on forty percent of its initial gains in a month and a half. However, after seven months of the war, Russia controlled three thousand square kilometres less than what it originally controlled after five days of war. Russia focused on annexing the Donetsk,

[87] Diptendu Choudhury , "Russo-Ukraine War: Air Power Analysis," March 9, 2022,
[88] Ibid.
[89] Ibid.
[90] "The Turning Points in Russia's Invasion of Ukraine," *CNN*, n.d..

Luhansk, Zaporizhzhia and Kherson regions into Russian territory but faces strong Ukrainian counter offensive since the late September 2022. So far, Ukrainian counter offensive had managed to regain much of Zaporizhzhia's territory. [91] Hence, despite Russia's potent military power, it failed to destroy the Ukrainian Defence Forces. The significant losses and mobilization efforts did not result in the decisive outcome Russia sought.[92]

So far, Russia has lost seven uncrewed combat aerial vehicles, 78 fixed-wing piloted aircraft, 80 helicopters,198 reconnaissance uncrewed aircraft, 26 radars, 7 UCAVs, 24 Self-Propelled Anti-Aircraft Guns, and 102 SAM.[93]

Gains and Losses on Ukrainian Side

Ukraine has achieved substantial gains militarily over the past 17 months with the help of western support. Initially, it prevented Russia from conquering Kyiv in matter of days which was Russia's initial objective. Ukraine has reversed Russian gains by re-conquering its territories from Russian hold. Ukrainian forces in their counter-offensive have managed to get hold of 75,000 square km of its territory, and in the process, Ukraine has prevented Russia from establishing control over Donbas.[94] Even though, the region has been occupied by Russia for the past eight years, Ukraine has twice seized the initiative on the battlefield, first one in 2022 summer and the other on in spring 2023.[95] Ukraine has been engaged in counter offensive against Russia in south. Ukraine has lost 17 combat UAVs, 76 reconnaissance UAVs, 17 UCAVs 61 fixed-wing piloted aircraft, 52 radars, 87 SAMS, 5 Self-Propelled Anti-Aircraft Guns and 31 helicopters.[96]

Use of Drones and UAVs in the Conflict

The conflict between Russia and Ukraine has introduced a new dimension to warfare, where drones play a pivotal role in shaping the battlefield. On the Russian side, drones like the SHAHED-136 and ORLAN-10 have been deployed extensively.[97] The SHAHED-136, an Iranian-made drone, is known for its larger size and explosive warhead, providing Russia

[91] Ibid.
[92] Dudko Volodymyr, "Success and Failures Russian Invasion in Ukraine since 24 February 2022. New Changes in the World's Military Concepts," Portal polsko-ukraiński, May 17, 2023.
[93] Angelo Young, "Russian and Ukrainian Weapon and Vehicle Losses in the War so Far – Page 6 – 24/7 Wall St.," July 27, 2023.
[94] Ibid.
[95] Ibid.
[96] Angelo Young, "Russian and Ukrainian Weapon and Vehicle Losses in the War so Far – Page 6 – 24/7 Wall St.," July 27, 2023.
[97] Isabelle Khurshudyan, "Russia and Ukraine Are Fighting the First Full-Scale Drone War," *Washington Post*, December 2, 2022, .

with reconnaissance capabilities and the ability to strike targets from a distance. The ORLAN-10, a Soviet-made drone, offers surveillance and artillery targeting capabilities.[98] Ukraine's drone arsenal includes the SWITCHBLADE 300, a small and versatile drone provided by the United States. Additionally, the BAYRAKTAR TB2, developed by Turkey, is a larger drone equipped with laser-guided missiles, playing a significant role in Ukraine's efforts to counter Russian forces.[99] The MATRICE 300 RTK and MAVIC 3, commercial drones, have also increased battlefield visibility for Ukrainian forces, aiding in reconnaissance and coordination.

Both sides have recognised the importance of drones in modern warfare and have integrated them extensively into their military strategies.[100] This conflict has showcased the evolution of drone technology and its significant impact on the battlefield. Drones have allowed both Russia and Ukraine to wage a war of precision from a distance, revolutionising traditional tactics and strategies. As the conflict continues, the use of drones is likely to remain a defining feature of this modern-day conflict.

Lessons for Airpower

Russia's invasion of Ukraine in February 2022 revealed significant failures in their military strategy, particularly in the realm of airpower. Despite intending to capture Kyiv swiftly and decapitate the Ukrainian government, Russian forces encountered numerous strategic and operational blunders that impeded their progress. Although Russia had numerical and technological superiority over the smaller Ukrainian Air Force, critical mistakes were made in the employment of airpower. The failures and successes of Russia and Ukraine air forces against each other leaves lessons for airpower in general and some lessons for airpower.

Technology / Weapons

- The use of precision-guided weapons by Russia was minimal (around 3% of total munitions used) compared to the US/NATO, which heavily relies on precision-guided munitions. This indicates the importance of investing in and utilising modern, accurate munitions for effective air operations.
- The Russia-Ukraine conflict underscores the transformative impact of drones and UAVs on modern warfare. Drones enable precise strikes, real-time intelligence, and

[98] Ibid.
[99] Ibid.
[100] Ibid.

psychological operations from a safe distance, and on low costs emphasising their crucial role in shaping battle outcomes.

Tactics and Strategies

- Russia's targeting strategy in Ukraine was characterized by striking a wide range of targets, including civilian and military assets. However, some strikes were directed at targets of little value, resulting in inefficiencies and a lack of desired impact. This emphasizes the need for precise target selection and the ability to prioritize high-value targets for optimal results.
- Russia's VKS neglected key airpower principles including air control, prioritising targets, force concentration, and balance between missions, leading to setbacks in their airforce performance which underscore the importance of adhering to these principles. Adaptability and situational awareness, along with rigorous training, are crucial for maintaining operational effectiveness.
- Russia's difficulty in employing airpower in Ukraine was hampered by its own doctrine, which sees the role of fixed-wing aircraft as supporting ground forces. Contrarily, Western air doctrine views airpower as an independent arm that can deliver decisive blows and support a joint campaign. This highlights the significance of developing and adapting air doctrines that align with the specific objectives and requirements of a conflict. The emphasis on ground support over air superiority strategies reflects a misunderstanding of modern warfare dynamics, underscoring the need for a more comprehensive approach.[101]
- Ukraine's survival against Russia's initial attack was achieved through intelligent dispersion of air defence assets. Maintaining dispersed tactical aviation, utilising dense air defence systems, and repairing assets in the field proved pivotal in countering a numerically superior adversary's assault.
- Ukraine's ability to endure a prolonged war despite significant numerical disparities rests on strategic factors such as intelligent defensive positioning, disruption of supply lines, steadfast leadership, and global diplomatic engagement which yielded in huge western military support. It demonstrates that for airpower to endure a battle against a bigger adversary, projection of its soft power on international stage can aid it to augment its military capabilities.

[101] Diptendu Choudhry, “Russia’s Military Understanding of Air Power: Structural & Doctrinal Aspects,” www.vifindia.org, May 23, 2022.

Command and Control

- Russia's air force remained subordinate to the Ground Forces, indicating the importance of flexible and adaptive command and control structures that can integrate air operations seamlessly with the overall military strategy.
- The Russian Air Force's issues with coordination and command become evident in their failure to integrate a cohesive counter air campaign with SEAD and AD strategies. This lack of synchronisation in missile attacks, air operations, and ground campaigns highlights organisational and coordination challenges, indicating problems at tactical and operational levels.

Training and Readiness

- The effectiveness of the Ukrainian air defence response was bolstered by the use of modern air defence systems, including the S-300 and S-400, accompanied by trained personnel. This emphasizes the significance of continuous training and readiness to operate advanced air defence systems effectively.
- Russia could not create air superiority despite it numerically outnumbered Ukraine. It highlights the importance of training and readiness as complex air operations are conducted in an atmosphere where the strike packages contain multiple types of aircraft in a highly threatened government.

Intelligence and Surveillance

- The Russia Ukraine war has highlighted the importance of open-source intelligence (OSINT). [102] In the modern warfare, the OSINT is usually based on the knowledge-sharing communities on social media, commercial capabilities, private sector AI tools, and Ukraine has used it widely to gather intelligence on Russia's moves and dispel the fog of battle. Hence, along with traditional modes of surveillance and intelligence, the wars in the digital era also rely on OSINT which incentivize its integration in the doctrines for airpowers around the world.

Jointness

- Russia's failure to achieve air superiority and its reliance on ground support for its air force highlight the importance of jointness in military operations. Integrating airpower,

[102] Tamir Hayman, "Open-Source Intelligence and the War in Ukraine," Inss.org.il, 2023.

ground forces, and other branches of the military is essential for achieving strategic objectives and overcoming challenges in complex conflicts.

National Morale

- The Ukrainian conflict highlights the pivotal role of high national morale. Ukrainian military and civilian morale have bolstered defence capabilities, while Russian-supported forces' low morale has offset their military superiority. This demonstrates that sustaining public and military morale is crucial for airpower effectiveness.[103]

Leadership

- The effective coordination of international support, military assistance, and training for Ukraine underscores the role of leadership in building alliances and empowering partners. The comparison between the Ukrainian and Russian forces' morale, discipline, and leadership demonstrates how effective leadership can significantly influence the outcomes of battles. Effective leadership can directly impact strategic goals, unity among allied forces, and the overall outcome of conflicts, making it a vital lesson for airpower leadership.[104]

Lessons for Pakistan Air Force (PAF)

- Airpower is becoming more varied and complex and for a small airpower there is a need to address this complexity to ensure relevance. PAF should focus on intelligent means to prevail for which it needs to be an innovative, adaptive, and learning organisation.
- PAF can expand its qualitative edge by focus on training and education to attain professional mastery over the already available assets. Even a big airforce like Russia could not gain control of the air over a smaller airforce like Ukraine because of its limited training in live flying hours and lack of experience in large-scale air operations. The PAF should prioritise continuous training, simulations, and joint exercises to prepare its pilots and ground personnel for complex and contested air environments.
- Lethal autonomous drones and UAVs play a crucial role in modern warfare, enabling precise strikes, real-time intelligence, and cost-effective operations. PAF can emphasise on the cost effective development and integration of drone capabilities into its strategies for improved battle outcomes.

[103] Jokull Johannesson, "The Critical Role of Morale in Ukraine's Fight against the Russian Invasion," *Open Journal of Social Sciences* 08, no. 06 (2020): 252–60.
[104] "Milley Says Ukraine Has Leadership, Morale to Beat Russia," *U.S. Department of Defense*, 2023.

- The ever increasing integration of artificial intelligence in the battlefield requires a resilient and secure cyber space as electronic warfare capabilities have played a crucial role in jamming techniques jamming drones, long-range rockets and attack helicopters and even reducing the accuracy of guided ammunitions from both sides.
- The Ukrainian conflict demonstrates the pivotal role of high national morale in bolstering defence capabilities. Ukraine's military and civilian morale played a significant role in enhancing their defence efforts, enabling them to effectively resist a militarily superior force. This underscores the importance of nurturing national morale within the PAF and the broader public. Building a sense of pride, commitment, and unity among personnel and citizens can contribute to enhanced performance and resilience during times of conflict. Encouraging patriotism and a strong connection between the Air Force and the nation can amplify overall effectiveness.
- The coordination of international support, military assistance, and training for Ukraine highlights the crucial role of leadership in building alliances and empowering partners. The comparison between the Ukrainian and Russian forces' morale, discipline, and leadership underscores how effective leadership significantly influences battle outcomes. For the PAF, effective leadership is essential not only within the ranks but also in diplomatic and strategic collaborations with allies. Strong leadership can shape strategic goals, foster unity among allied forces, and ultimately impact the success of operations.

Conclusion

The role of air power in modern warfare has become increasingly significant due to the rapid advancements in technology and the emergence of various disruptive capabilities. Air power has evolved continuously since World War I, and it now offers strategic, operational, and tactical advantages to military forces. In the context of the Russia-Ukraine conflict, the Russian Air Force demonstrated substantial strength with its modern and diverse aircraft fleet, advanced air-launched missiles, precision-guided munitions, and robust air defence network. On the other hand, the Ukrainian Air Force faced challenges due to limited defence budgets and reliance on older aircraft models. However, Russia's offensive and defensive strategy in the conflict with Ukraine has been marked by mixed results and significant challenges. Despite launching a large-scale military operation, Russia failed to achieve air superiority and faced resistance from the Ukrainian Air Force and air defence systems. The targeting strategy employed by Russia, while initially effective in some areas, also showed inefficiencies and lacked the desired impact. On the offensive side, Russia conducted numerous sorties and

employed a variety of strike packages, but its aerospace force remained subordinate to ground forces, limiting its overall effectiveness in achieving strategic objectives. Ukraine, on the other hand, demonstrated resilience and effectiveness in countering Russian aggression with the support of its allies. It dispersed its air assets and utilised its airpower effectively in targeting Russian air defence systems. The assistance from the US and other allies allowed it to protect its territory and launch successful counter-offensives. This commitment from its allies has facilitated the provision of advanced weaponry, training, intelligence, surveillance, reconnaissance assets, and air defence systems, significantly boosting Ukraine's defence capabilities

Russia's invasion of Ukraine exposed significant shortcomings in their military approach, particularly in the realm of airpower. The use of outdated doctrine which considers air power as a subservient force to ground forces effectively halted its potential to create air superiority in the initial phase of war. Moreover Russia’s inadequate targeting strategies and limited experience in complex air operations hindered Russia's ability to gain air superiority and effectively strike high-value targets. There are some major lessons for airpower in this conflict which includes the need to develop and adapt air doctrines that align with specific conflict objectives. Flexibility in command and control structures to seamlessly integrate air operations with overall military strategies is crucial for success. Furthermore, the use of open-source intelligence (OSINT) in modern warfare was exemplified by Ukraine's reliance on knowledge-sharing communities, social media, and AI tools to gather critical intelligence on Russia's moves. Ultimately, the Russia-Ukraine conflict is a complex and evolving scenario, influenced by various factors such as military strategies, technological advancements, and international support. The situation underscores the significance of air power in modern warfare and the need for nations to adapt and modernise their capabilities to effectively address security challenges.

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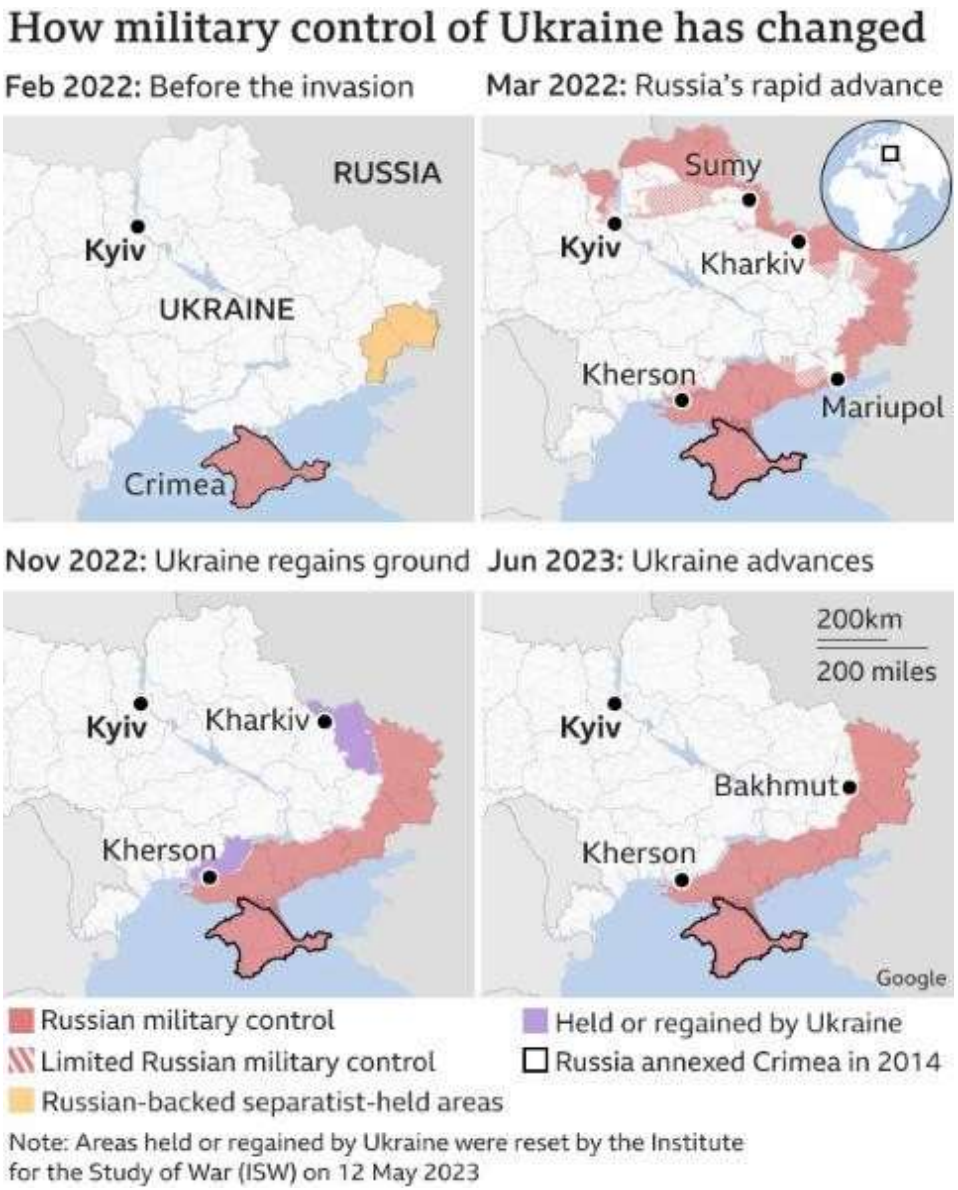
Appendix

Annexure A

Source: Brown, David. “Ukraine Invasion: Russia’s Attack in Maps.” *BBC News*, February 24, 2022, sec. Europe. https://www.bbc.com/news/world-europe-60506682.



Annexure B

Russian Air Force Assets

Source: International Institute for Strategic Studies. *The Military Balance 2023*. 1st ed. Routledge, 2023.

Active Personnels	1,190,000
Air Force Personnels	165,000
Defence Budget	**2021** 48.5bn USD 3.58tr Rub **2022** 66.9bn USD 4.68tr Rub **2023** 61.5bn USD 4.98tr Rub
Strategic Rocket Force	50,000
Surface-to-Surface Missile	**Numbers and Types**
	1 ICBM regt with RS-12M Topol (RS-SS-25 Sickle)
	8 ICBM regt with RS-12M2 Topol-M (RS-SS-27 mod 1)
	2 ICBM regt with RS-18 (RS-SS-19 Stiletto)
	1 ICBM regt with RS-18 with Avangard HGV (RS-SS-19 mod 4 Stiletto)
	8 ICBM regt with RS-20 (RS-SS-18 Satan)
	14 ICBM regt with RS-24 Yars (RS-SS-27 mod 2)
	7 ICBM regt with Yars-S
	Counter Space • DE • Laser Peresvet

Air-Launched Missiles	**Numbers and Types**
AAM	IR R-27T/ET (RS-AA-10B/D Alamo); R-73 (RS-AA-11A Archer); R-74M (RS-AA-11B Archer); R-60T (RS-AA-8 Aphid); SARH R-27R/ER (RS-AA-10A/C Alamo); R-33 (RS-AA-9A Amos); ARH R-77-1 (RS-AA-12B Adder); R-37M (RS-AA-13A Axehead); PRH R-27P/EP (RS-AA-10E/F Alamo)
ARM	Kh-25MP (RS-AS-12A Kegler); Kh-31P/PM (RS-AS-17A/C Krypton); Kh-58 (RS-AS-11 Kilter)
ASM	Item 305/LMUR; Kh-25ML (RS-AS-12B Kegler); Kh-29 (RS-AS-14 Kedge); Kh-38; Kh-59 (RS-AS-13 Kingbolt) Kh-59M (RS-AS-18 Kazoo); Kinzhal (RS-AS-24 Killjoy); 9M114 Kokon (RS-AT-6 Spiral); 9M120 Ataka (RS-AT-9 Spiral 2); 9M120-1 Vikhr (RS-AT-16 Scallion)
AShM	Kh-22 (RS-AS-4 Kitchen); Kh-31A/AM (RS-AS-17B/D Krypton); Kh-32 (RS-AS-4A mod); Kh-35U (RS-AS-20 Kayak)
LACM	Nuclear Kh-55SM (RS-AS-15B Kent); Kh-102 (RS-AS-23B Kodiak)
	Conventional Kh-101 (RS-AS-23A Kodiak); Kh-555 (RS-AS-22 Kluge)

Long Range Aviation Command	
Aircraft	
BBR	76:
	9 Tu-160 Blackjack with Kh-55SM (RS-AS-15B Kent) nuclear LACM
	7 Tu-160 mod Blackjack with Kh-55SM (RS-AS-15B Kent)/Kh-102 (RS-AS-23B Kodiak) nuclear LACM
	42 Tu-95MS Bear H with Kh-55SM (RS-AS-15B Kent) nuclear LACM
	18 Tu-95MS mod Bear H with Kh-55SM (RS-AS-15B Kent)/Kh-102 (RS-AS-23B Kodiak) nuclear LACM

Space Equipment by Type	
Satellites	89
	15 Rodnik-S (Strela-3M)
Positioning, Navigation & Timing	27:
	3 GLONASS-K1
	24 GLONASS-M
ISR	10:
	3 Bars-M
	2 GEO-IK-2
	1 Neitron
	2 Persona
	2 Resurs-P

Aerospace Force Assets	Numbers and Types
Bomber	3 regt with Tu-22M3 Backfire C
	3 sqn with Tu-95MS/MS mod Bear
	1 sqn with Tu-160/Tu-160 mod Blackjack
Fighter	1 sqn with MiG-29/MiG-29UB Fulcrum (Armenia)
	2 regt with MiG-31BM Foxhound C
	1 regt with MiG-31BM Foxhound C; Su-35S Flanker M
	1 regt with Su-27/Su-27SM/Su-27UB Flanker B/J/C; Su-30M2 Flanker G

Aerospace Force Assets	Numbers and Types
	2 regt with Su-30SM Flanker H
Fighter/Ground Attack	1 regt with MiG-31BM Foxhound C; Su-27SM Flanker J; Su-30M2 Flanker G; Su-30SM Flanker H; Su-35S Flanker M
	1 regt with Su-27SM Flanker J; Su-35S Flanker M
	1 regt with Su-35S Flanker M; Su-30SM Flanker H
	1 regt with Su-27SM3 Flanker; Su-30M2 Flanker G
	1 regt with Su-25 Frogfoot; Su-30SM Flanker H
Ground Attack	1 regt with MiG-31K
	1 regt with Su-24M/M2 Fencer; Su-34 Fullback
	1 regt with Su-24M Fencer; Su-25SM Frogfoot
	3 regt with Su-25SM/SM3 Frogfoot
	1 sqn with Su-25SM Frogfoot (Kyrgyzstan)
	3 regt with Su-34 Fullback
Ground Attack/ISR	1 regt with Su-24M/MR Fencer
ISR	3 sqn with Su-24MR Fencer
	1 flt with An-30 Clank
Airborne Early Warning & Control	1 sqn with A-50/A-50U Mainstay
Tanker	1 sqn with Il-78/Il-78M Midas
Transport	6 regt/sqn with An-12BK Cub; An-148-100E; An-26 Curl; Tu-134 Crusty; Tu-154 Careless; Mi-8 Hip
	1 regt with An-124 Condor; Il-76MD Candid
	1 regt with An-124 Condor; Il-76MD/MD-90A Candid
	1 regt with An-12BK Cub; Il-76MD Candid

Aerospace Force Assets	Numbers and Types
	1 sqn with An-22 Cock
	3 regt with Il-76MD Candid
Attack/Transport Helicopter	1 bde with Ka-52A Hokum B; Mi-28N Havoc B; Mi-35 Hind; Mi-26 Halo; Mi-8MTV.
Uninhabited Aerial Vehicles	CISR • Heavy some Inokhodets; Medium Forpost R; Mohajer 6
	ISR • Medium Forpost (Searcher II)

Air Defence	Numbers and Types
SAM	714:
	Long-range 584:
	160 S-300PS (RS-SA-10B Grumble)
	150 S-300PM1/PM2 (RS-SA-20 Gargoyle)
	20 S-300V (RS-SA-12 Gladiator/Giant)
	6 S-350 Vityaz (RS-SA-28)
	248 S-400 (RS-SA-21 Growler)
	Medium-range 80 9K37M1-2 Buk-M1-2/9K317 Buk-M2 (RS-SA-11 Gadfly/RS-SA-17 Grizzly)
SPAAGM	30mm 50 96K6 Pantsir-S1/S2 (RS-SA-22 Greyhound)
BOMBS	
INS/GLONASS-guided	KAB-500S
Laser-guided	KAB-500L; KAB-1500L
TV-guided	Ghaem-5; KAB-500KR; KAB-1500KR; KAB-500OD; UPAB 1500

Annexure C
Ukrainian Air Force Assets

Source: International Institute for Strategic Studies. *The Military Balance 2023*. 1st ed. Routledge, 2023.

Active Personnels	688,000
Active Air Force Personnels	37,000
Defence Budget	2021 4.30bn 2022 3.55bn 2023 30.6 bn
Assets	**Numbers and Types**
Air-Launched Missiles	**AAM** • IR R-27ET (RS-AA-10D Alamo); R-60 (RS-AA-8 Aphid); R-73 (RS-AA-11A Archer); SARH R-27R (RS-AA-10A Alamo); R-27ER (RS-AA-10C Alamo) **ASM** Kh-25 (RS-AS-10 Karen); Kh-29 (RS-AS-14 Kedge) **ARM** AGM-88 HARM; Kh-25MP (RS-AS-12A Kegler); Kh-58 (RS-AS-11 Kilter)
Fighter	4 bde with MiG-29 Fulcrum; Su-27 Flanker B; L-39 Albatros
Fighter/Ground Attack	2 bde with Su-24M Fencer; Su-25 Frogfoot
ISR	2 sqn with Su-24MR Fencer E*
Transport	3 bde with An-24 Curl; An-26 Coke; An-30 Clank; Il-76 Candid; Tu-134 Crusty
Training	Some sqn with L-39 Albatros
Transport Helicopter	Some sqn with Mi-8 Hip; Mi-9 Hip; PZL Mi-2 Hoplite
Aircraft	79 combat capable FTR 50: ε20 MiG-29 Fulcrum; ε30 Su-27 Flanker B ATK 20: ε5 Su-24M Fencer D; ε20 Su-25 Frogfoot ISR 12: 3 An-30 Clank; ε9 Su-24MR Fencer E* TPT 26: Heavy 4 Il-76 Candid; Medium 1 An-70; Light ε21: 3 An-24

		Coke; ε17 An-26 Curl; 1 Tu-134 Crusty
		TRG ε31 L-39 Albatros
Helicopters		C2 ε14 Mi-9 Hip
		MRH ε25 Mi-17 Hip H
		TPT 25: Medium ε20 Mi-8 Hip; Light ε5 PZL Mi-2 Hoplite
Uninhabited Vehicles	Aerial	CISR • Medium Bayraktar TB2
		ISR • Heavy some Tu-141 Strizh
Air Defence		**Numbers and Types**
SAM 271:		Long-range 208: 200 S-300PS/PT (RS-SA-10 Grumble); 8 S-300PMU (RS-SA-10 Grumble)
		Medium-range 63: 60 9K37M Buk-M1 (RS-SA-11 Gadfly); 3+ IRIS-T SLM
		Short-range NASAMS
		6 bde with S-300PS/PT (RS-SA-10 Grumble); 3 regt with S-300PS/PT (RS-SA-10 Grumble); 3 regt with 9K37M Buk-M1 (RS-SA-11 Gadfly)

Annexure D

Allied Support to Ukraine

Source: Masters, Jonathan, and Will Merrow. "How Much Aid Has the U.S. Sent Ukraine? Here Are Six Charts." Council on Foreign Relations, July 10, 2023. https://www.cfr.org/article/how-much-aid-has-us-sent-ukraine-here-are-six-charts