

# Armored Modular and Non-Modular Vehicle: A Survey

M. Sheik Dawood, A. Fardhan Ahmed, M. Jehosheba Margaret, C. Yesubai Rubavathi

**Abstract:** Armored vehicles are being used in the defense sector for many years. The armored vehicles have been so efficient and productive and have survived these many years. In the year 1995, a new concept was introduced called modular vehicles, which means we can use one vehicle for almost all purposes. In the defense sector, the number of modular vehicles is less compared to the non-modular vehicles. If we choose the future with modular vehicles it is going to be the wisest decision which we take. The modular vehicles are better in every way when compared with non-modular vehicles. In this paper, we present a detailed survey on both the modular and non-modular vehicles used in the defense sector and we suggest a more advanced modular vehicle which can serve the defense sector for years without a need of replacement.

**Keywords:** Armored Modular Vehicle (AMV), Central Tire Inflation System (CTIS), All-Welded Steel, Armored Personnel Carrier (APC), Light Armored Vehicle (LAV), Non-Modular.

## I. INTRODUCTION

The modular concept is an emerging technology which is going to be used in many fields like in electronic devices, vehicles, space probes, consumer products etc. The meaning of modular is defined as “employing or involving a module or modules as the basis of design or construction”. When we apply the concept of modules to vehicles we can have a simple and elegant picture which shows a common base structure and we can add any kind of modules we want based on our requirement. If we have modular products the first thing that is going to be reduced is the time and parts that are used to manufacture non-modular products. The time it takes to manufacture a vehicle can be reduced drastically because you are going to build a common base structure for all of your vehicles. On the other hand the parts, the modules we use also have common base structures in them and you do not need to manufacture new parts and assembly lines which is going to cost a lot. This is how efficient a modular vehicle can be, this is just the beginning of the world of modules there is a lot more we can do with it. Now let’s look into the developments being made in the world of modular products. Engineers and scientists are working to design and convert everything into a modular product. Google, one of the biggest tech tycoon introduced modular electronic devices like a modular mobile phone.

**Manuscript published on 28 February 2019.**

\* Correspondence Author (s)

**M. Sheik Dawood\***, Dept. of ECE, Sethu Institute of Technology, Kariapatti, Virudhunagar, India.

**A. Fardhan Ahmed**, Dept. of ECE, Sethu Institute of Technology, Kariapatti, Virudhunagar, India.

**M. Jehosheba Margaret**, Dept. of ECE, Sethu Institute of Technology, Kariapatti, Virudhunagar, India.

**C. Yesubai Rubavathi**, Dept. of CSE, Sethu Institute of Technology, Kariapatti, Virudhunagar, India.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

The most stunning thing in the universe is interstellar, humans are working on it for many years and there have been made a lot of discoveries.

All the space probes and satellites are modular in nature. So we are getting into the world of modules because we find it more efficient than anything. Calculating the time it will take for us to achieve a 100% modular environment will be in 5 to 6 years. We find this is the appropriate time to get involved in the modular ecosystem and look forward to the betterment of the human future. This survey is mainly taken to review the armored modular and non-modular vehicles that are available in the defense sector. An updated version from the below mentioned armored modular and non-modular vehicle can be designed. The features that the vehicle should have to fulfill the requirements of a modular vehicle should be as follows, the vehicle can have a tank design, the reason for choosing the tank design is because the tanks are basically meant to be strong, protective and withstand anything that comes in their way, It can also have a technological feature built in it which is an Auto Pilot System so that it can go to places without an extra need of soldiers and can perform a reconnaissance activity by itself without risking lives. It has got a lot of advantages having the autopilot system installed in it. The vehicle must have the most important feature that an armored vehicle should have and that is the All-Terrain Response, which allows the vehicle to go anywhere at any time. In the following sections, we will be discussing different Modular and Non-Modular Vehicles being used and the upcoming vehicles in the Defense sector. The vehicles we are going to discuss are as follows: Non-Modular Vehicles: TATA Kestrel, Stryker, BTR-90 & LAV-III Modular Vehicles: Patria AMV, Boxer & Havoc AMV

## II. TATA KESTREL

The TATA Kestrel is an 8X8 Armored fighting vehicle. This vehicle has been built for the survival of the troops, to give protection from arm fires and hidden explosives. It is an 8X8 all-wheel drive vehicle. This vehicle has installed a hydropneumatic suspension which helps to get a comfortable ride. TATA Kestrel’s wheels have the capability to run flat which is very helpful in battlefields. TATA Kestrel’s wheels have the capability to run flat which is very helpful in battlefields. The vehicle has 4 axles and the front axle is the only axle which is steerable as it can reduce the turning radius of the vehicle. When it comes to protecting the TATA Kestrel’s armor is made up of appliqué and composites along with welded steel. An additional armor kit is available for extra protection. The hull floor which helps in defeating mines and similar ones.

## Armored Modular and Non-Modular Vehicle: A Survey

The glacis plate in the vehicle is very shallow and the fuel tank is mounted outside of the vehicle to improve its survivability. The standard operating crew consisting a driver and commander with mechanized squad of 12 members. The seats in the vehicle are attached in the roof to improve blast protection fuel tank is placed outside the troop compartment that is outside the vehicle. The passengers are placed back to back fashion. The seats are comfortable compared to the old BMP's. The engine is placed in the front left portion of the vehicle. It has a high power-to-weight ratio which comes from the turbocharged diesel engine with 600hp. TATA Kestrel is fully amphibious, it is fitted with two water jets at the lower corners of the hull rear.[1][3] The standard turret installation can also accept a roof mounted Remote Weapons Station (RWS). The standard arrangement sees the vehicle field a 30mm auto-cannon and 7.62mm coaxial machine gun. A 12.7mm heavy machine gun is added to the remote weapons station. The vehicle is granted support stations for up to 2 x Anti-Tank Guided Missile (ATGM) launchers. A single vehicle can pledge enemy infantry, light armored vehicles, and frontline combat tanks. Firing ports along the hull side introduce the prospect of passenger infantry bringing their personal weapons to bear in a firefight. [1] The TATA Kestrel are manufactured to replace the old Soviet BMP's and APC's in Indian army. The Indian army has a large fleet of BMP-1's and BMP-2's and different types of APC's from the Soviet Union. The abovementioned vehicles are no longer capable to meet the requirements of the modern warfare. There are many western vehicles which are capable to do and with more advanced technology integrated into them when compared with the Indian army's APC's and BMP's. To meet the requirements TATA and Defense Research and Development Organization (DRDO) of India partnered to manufacture the TATA Kestrel. [1][4] The TATA Kestrel has very strong armor protection which is made up of applique and composites along with welded steel and an additional armor kit is available for extra protection. The hull is designed in such an away which can withstand mines and similar underground explosives. Since the seats are attached to the top of the roof it increases blast protection and the fuel tank placed outside the troop compartment gives extra protection to the crew. The back to back fashion of seats helps more passengers to fit and stay comfortable.

The wheels have run flat capability which will be used in cases of punctures. The turbocharged diesel engine with 600hp gives high power-to-weight ratio which is helpful in mountain climbing and the vehicle is fully amphibious. [1][5] The TATA Kestrel is manufactured by TATA and DRDO. The first prototype was revealed in 2014 also had a remotely controlled weapon station with a 12.7mm machine gun. A Kestrel was revealed in 2016, fitted with a complete turret of the BMP-2 infantry fighting vehicle, armed with a 30 mm automatic cannon. It is in service since 2017 and the country of origin is India. Refer Fig. (1) and Fig. (2). [2]



**Figure 1 - TATA Kestrel under testing process;**



**Figure 2 - TATA Kestrel on display;**

*Table 1 - TATA Kestrel: Specifications, Uses, Advantages and Disadvantages;*

Specifications [1]	Uses	Advantages	Disadvantages
Weight: 25 Tons Length, Width & Height: 7.8 m, 2.95 m & 2.28 m. Crew: 3+9 Armor: Applique and Composites along with Welded Steel. Main Armament: 30mm Automatic Canon. Secondary Armament: 7.62mm Coaxial MG Engine: 1 x Diesel fueled engine Power: 600 HP Speed: 100 Km/h (On Road) & 10 Km/h (On Water). Origin: India	It can be used in different battlefields.	Low Cost, Smaller in size and Good swim speed in water.	The weight is heavier, The armor is not strong and The armament used is not powerful enough for the current battlefield.

### III. STRYKER

The Stryker is an Interim Armored Vehicle (IAV) and it has an 8x8 drive. The design of IAV Stryker is based on the design of LAV III light armored vehicle which is similar to Swiss MOWAG Piranha III 8X8. There are different variants available in the vehicle and each of them is made to serve specific needs. The vehicle comes in different modifications but the engine, hydraulic system, tires, differentials, wheels and transfer case are found to be common. The Stryker is installed with a Caterpillar diesel engine. The caterpillar engines are mostly used in U.S Army and this reduces the extra training for the crew members and paves them to use normal design. The caterpillar 3126 is switched to Caterpillar C7 engine and the design of Allison 3200 SP transmission system has been installed in it. All the mechanical features are supported with a Pneumatic or Hydraulic System. The pneumatic systems help in switching between 8x4 and 8x8 drive. The designers of the IAV Stryker have made the maintenance job easy. A quick disconnecting mechanism is equipped with cables, hoses and mechanical systems. Within the time period of 2 hours, the transmission system and engine can be dismantled and brought back which is considered to be the hardest tasks in mechanical workshop. [6]. The Stryker is highly valued for the protection system it is installed with which helps in withstanding a range of explosives and etc. the Stryker's hull is constructed from a high hardness steel with a basic level of protection against 14.5mm rounds and an all-around protection against 7.62mm ball ammunition. An additional armor is added with the bolt-on ceramic armor which gives protection against 14.5mm, armor-piercing ammunition and artillery fragments from 155mm rounds. The hull of the can also protect itself against mines and concealed explosives. The vehicle has three armor packages in which Slat armor and Stryker Reactive Armor Tiles (SRAT) has been used for protection against grenades, Hull protection kit for explosive devices and finally ballistic shield for commander's protection. The tile has to be manufactured specifically for each vehicle to have a proper fit. The Stryker has an automatic system which extinguishes the fire with the help of sensors in the engine which in turn alerts the troops to activate halon fire bottles and this system can be activated by the driver from his dashboard. For extra protection the fuel tank is mounted externally that is outside the crew compartment and a CBRN (Chemical, Biological, Radioactive, Nuclear) warfare system is used to keep the crew airtight and positively pressurized. A Camouflage system is available in the vehicle which changes the physical look to merge with the environment. An Iron curtain active protection system is integrated onto the Stryker as a temporary system and the Iron Curtain are different from the APS, it can defeat projectiles with small distance from the vehicle, then diverting them several meters out. The IAV Stryker has an advanced computer system with which a friendly fight is reduced. We can use the computers to identify both friendly and enemy vehicles on the battlefield. The vehicle is installed with a periscope that allows the gunner (Commander on the vehicle) to monitor outside without revealing him to the outside damage. The commander has to use a day-night thermal imaging camera so that he can monitor the activities of the driver. The thermal sight range is up to 7,200ft. (2,400m; 1.48mi). The commander has a field vision of 360-degree

and the driver has a 90-degree field of vision. Moreover, the practice can be done from the training modules found within the vehicle. [6]

The IAV Stryker is a heavy vehicle so the transportation of these vehicles really matters. The Stryker is transported using a C-130 aircraft. With the slat tile the vehicle adds up weight and size, all the vehicles with slate tile is transported using an Airbus A400M Atlas. The Stryker can also be airdropped, the first test was at a height of 12-foot drop done with a C-17 aircraft and the test results were positive. The 8 tires in the Stryker are made to suit highway, cross country, mud/snow/sand, and the tires are run-flat tires which can run even when they get flat and it has bead-lock, it also allows the vehicle to run in lower speed until the tire completely destroys. The Stryker has different variants with the main chassis of the Infantry Carrier Vehicle. The different variants are as follows: 1) M1126 Infantry Carrier Vehicle (ICV)[7], 2) M1127 Reconnaissance Vehicle (RV)[8], 3)

M1128 Mobile Gun System[9], 4) M1129 Mortar Carrier (MC)[10], 5) M1130 Commanders Vehicle (CV)[11], 6) M1131

Fire Support Vehicle (FSV)[12], 7) M1132 Engineer Squad Vehicle (ESV)[13], 8) M1133 Medical Evacuation Vehicle (MEV)[14], 9) M1134 Anti-Guided Missile Vehicle (ATGM)[15] and 10) M1135 Nuclear, Biological, Chemical Reconnaissance Vehicle (NBCRV)[16]. Only a few of the above-mentioned vehicles have double V-hull and they are as follows 1) M1251 FSVV, 2) M1252 MCVV, 3) M1253 ATVV, 4) M1254 MEVV, 5) M1255 CVV, 6) M1256 ICVV and 7) M1257 ESVV. The vehicles without a V-hull are 1) M1127 RV, 2) M1128 MGS and 3) M1135 NBCRV. The IAV is operated mainly in the USA in the US Army and they own 4,466 units and the other operator in Peru in the Peruvian Army with 178 units. [6]

The IAV Stryker was manufactured to replace the older IAV's and LAV used in the US Army and to replace the outdated vehicles. The US Army thought of bringing an innovative age of a vehicle to the contemporary warfare. So the General Dynamics Land System designed the Stryker for the US Army. The Stryker has come beneath powerful examination from military authority since its introduction in the US Army; this has also been the subject of mass media coverage. [6] The uses of IAV Stryker are so much more than what it looks like. It is an 8x8 vehicle which is very helpful in many applications of the battlefields and the 8 tires are prepared to ensemble highway, cross country, and various hostile environment. The different variants of the vehicle help the soldiers to stay a single platform and the training is also less time-consuming. It has got a heavy-duty engine from the Caterpillar; the C7 Engine is so powerful which gives 350hp and a speed of approximately 100 km/h and an operational coverage of 500km. The armor is the vehicle is one of the biggest features which helps in defending and protecting the crew and a lot more and the armor used is Bolt-on Ceramic Armor and it has got armor packages like SRAT and HPK. The mobility and transportation of the Stryker are also easy and it has also got an Airdrop feature. The cost of an IAV Stryker is 4.9 Million USD. Refer Fig. (3) and Fig. (4). [6]

## Armored Modular and Non-Modular Vehicle: A Survey



**Figure 3 - Stryker Infantry Carrier Vehicle (M1126);**



**Figure 4 - Stryker Medical Evacuation Vehicle (M1133);**

*Table 2 - Stryker: Specifications, Uses, Advantages and Disadvantages;*

Specifications [6]	Uses	Advantages	Disadvantages
Weight: 18.77 Tons Length, Width & Height: 6.95 m, 2.72 m & 2.64 m. Crew: 2+9 Armor: 14.5mm Resistant Main Armament: 105 mm M68A2 gun (on M1128 Mobile Gun System), 0.50 in M2 machine gun, 40mm Mk 19 grenade launcher mounted in a Protector remote weapon station, or 30mm Mk44 Bushmaster II gun. Secondary Armament: 0.50 in caliber M2 and 7.62mm M240 machine guns. Engine: Caterpillar C7 Power: 350 HP Suspension: 8x8 Wheeled Range: 500 Km Speed: 97 Km/h Origin: Canada	Different variants available in various situations and The double V-hull structure gives increased protection to the vehicle and the crew. The Stryker is an Interim Armored Vehicle (IAV) which is highly demanded.	Low Cost, It has a Double V-hull Structure, large number of variants and The soldier need not come out of the vehicle to use the top mounted weapons because it can be operated from the inside itself.	High cost, It is not a modular vehicle since it has got lot of different variants available and the vehicle produces less horsepower.

### I. BTR-90

The BTR-90 is an Armored Personnel Carrier (APC) and it has an 8x8 drive. The vehicle is similar to LAV-25 (Light Armored Vehicle-25). The hull of the vehicle is made up of steel armor plate which gives more strength to withstand incoming attacks and keep the crew safe. The BTR-90 is slightly larger and higher when compared to BTR-80, a predecessor in the lineup of the BTR vehicles. The BTR-90 is developed from its predecessor BTR-80. The BTR-90 is powered with a turbocharged engine with a liquid cooling system installed in it, the vehicle produces a 510hp which is developed from a multi-fuel diesel engine. The BTR-90 has 8 wheel drive built in it. It has a very special type of transmission which is so unique in many ways, the BTR-90 has an Automatic Reversible Hydro Mechanical Transmission. This transmission provides different speed to each side of the wheel.

The wheels in the BTR-90 have independent torsion-bar suspension built in it. A traverse arm installed in the BTR-90 has a high capacity telescope hydraulic shock absorber. The communication plays a very important role in this field, the R-163-50U broadcasting is used for external communications and on the other hand, the R-163UP receiver and R-174 intercom equipment are used for providing communication for crew members. [17][18]

Let us see the capabilities and features of the BTR-90, the vehicle can reach a maximum speed of 100 km/h which is

very useful in the battlefields. The BTR-90 is fully amphibious and it is motorized with two water jet propellers that control the vehicle in the water. The speed that the vehicle can reach in water is 9 km/h. Deploying the vehicle into the battlefield is very important and in many occasions, it becomes so tedious to do so. The BTR-90 can be deployed by any transportation like a truck, rail, water and also from the air. The maneuverability is increased in this vehicle due to the hydro-mechanical transmission and it has a low turning radius of 6m. The BTR-90 uses only the front four wheels to steer and due to that, we get a turning radius of 14m. The inner capacity of the BTR-90 is 12 cubic meters and it can carry a load of 1000kg. The vehicle comes with an Air Conditioning system which is optional. The BTR-90 has the most intelligent and advanced system installed in it that is an Onboard Information Control System (OICS). The OICS enables automatic control over the transmission, engine and other important parts of the BTR-90. The BTR-90 is the first Armored Personnel Carrier (APC) to have an automatic control system built in it. The BTR-90 has another feature, a centralized tire pressure control system is installed which allows the vehicle to move even when four of its wheels are destroyed. The BTR-90 is one of the most powerful APC's in the military world. [17]

The gunner and commander of the vehicle are placed in the fighting compartment in the turret. The fighting compartment includes a gunner for the commander, it has an optical sight. The driver is located in the center of the hull. The crew is positioned behind the hull and the turret. The engine is cited in the rear of the hull which is secure in many ways. The BTR-90 is designed this way to allow quick loading and unloading the troop. A power steering is installed in the front two pairs of the wheel. [17][19]

The weapons in the vehicle are mounted on the turret and supported by the fire management system and the weapons can be used while the vehicles are moving. There are two different variants in the BTR-90 and they are as follows: BTR-90M and Krymsk. The BTR-90M is an upgraded version of the BTR-90. The Krymsk is a remote control



Figure 5 - Basic BTR-90 with 30 mm machine gun on display;

platform and the vehicle is installed with LASER or Electromagnetic Wave weapons. The armament consists of a main gun 30mm cannon with 500 rounds and machine guns of 1x7.62mm with 2000 rounds. The ATGW missiles are also installed and it is a 1xKonkurs launcher with 5 missiles. The BTR-90 is complete weaponry package and it's tough to stand against it. [17][18]

The BTR-90 was introduced to meet the new military standards and overcome the disadvantages from its predecessors like the BTR-60, BTR-70, and BTR-80. The BTR-90 is more refined now and had more advanced technology when compared to its predecessors. The BTR-90 is manufactured in Russia and the BTR-90 costs \$340,000. Refer Fig. (5) and Fig. (6). [17] [20]



Figure 6 - BTR-90 ready for combat;

Specifications [17]	Uses	Advantages	Disadvantages
Weight: 20.9 Tons Length, Width & Height: 7.64 m, 3.20 m & 2.98 m. Crew: 3+7 Armor: Welded steel with optional ERA modules. Main Armament: 30 mm Shipunov 2A42 cannon (500 rounds) Secondary Armament: 7.62 mm PKT machine gun (2000 rounds), 9M113 Konkurs ATGM, one AGS-17D 30 mm automatic grenade launcher (400 rounds). Engine: Turbocharged Diesel Engine. Power: 510 HP Suspension: 8x8 Wheeled Range: 800 Km Speed: 100 Km/h Origin: Russia	The vehicle can be used as a battlefield controller, almost number of 3 crew can be used and they are Gunner, Commander and Driver.	Low cost, It has a powerful armament installed in the vehicle and The vehicle can move even if 4 of its wheels are destroyed.	It is an old vehicle and It has very less passenger accommodation.

## II. LAV-III (KODIAK)

The LAV-III is a Light Armored Vehicle (LAV) built by Canada for the Canadian Army and New Zealand Army. The vehicle was originally named as Kodiak, it is the third generation of the Light Armored Vehicle (LAV). The LAV-III is armed through a central tire inflation system, which assists the vehicle to correct to diverse terrain, including off-road. The LAV-III's ground pressure is higher than the

tracked vehicles which result in making the vehicle sink in soft terrains such as mud, snow, and sand, leading the vehicle to get stuck. But the LAV-III can make its way easily when it comes to managing slopes, trenches, and other obstacles.



## Armored Modular and Non-Modular Vehicle: A Survey

The vehicle's turret gives a higher center of gravity and it has led to the concern that the vehicle is more likely to roll over on uneven terrain. The vehicle has encountered about 16 rollovers it is commonly found because of the uneven terrain. [21] The vehicle is exceedingly defensive in the war fields; the vehicle is sheltered with the Standardization Agreement STANAG 4569 level III armor. For shield against shaped charges the LAV-III is snug with a cage armor. The LAV-II is also snug with a nuclear, biological, chemical categorization structure. The grenade launchers used in the LAV-III are intended for smoke grenades. The LAV-III has a remotely controlled weapon station (RCWS) with a modified Nanuk. The LAV-III has an optical Thermal Imaging System (TIS) and a Generation III Image Intensification (II). The LAV-III is fitted with a Tactical Navigation System (TacNav) to assist in navigation and target location tasks and it is also fitted with an LCD monitor directly connected to the vehicles external cameras, providing real-time images of the battlefield for the



**Figure 7 - LAV-III on snow land;**

passengers. [21][22] The LAV-III was initiated in the year 1991 when the Canadian military acknowledged the need to supplant the aged 1960s and 1970s era armored vehicles in their fleet. As a result, the Canadian Government invested \$2.8 billion in the Multi-Role Combat Vehicle (MRCV) project. The LAV-III or Kodiak is initially entered service in the year 1999. The LAV-III belongs to the Infantry fighting vehicles family of the General Dynamics Land Systems. The unit cost of the LAV-III is about \$1,900,000. The LAV-III is operated in many countries and they are as follows: Canada, New Zealand, Saudi Arabia, Colombia, and the United States. [21][23] There is a new upgraded version of LAV-III is being built called the LAV 6.0. It contains an innovative and influential engine, protection and brake systems. The weight of the LAV 6.0 will be increased from 17 tons to 25 tons. The final accomplishment and availability of LAV-III to the LAV 6.0 in Canadian army is expected by 2019. Refer Fig. (7) and Fig. (8). [21]



**Figure 8 - LAV-III in Afghanistan War (ISAF);**

Specifications [21]	Uses	Advantages	Disadvantages
Weight: 16.95 Tons Length, Width & Height: 6.98 m, 2.7 m & 2.8 m. Crew: 3+7 Armor: Standardization Agreement STANAG 4569 level III. Main Armament: 1 × M242 25 mm chain gun with TIS Secondary Armament: 1×C6 7.62mm machine gun (coaxial) 1×C9A2 5.56mm or C6 7.62 mm machine gun (pintle mount) Engine: Caterpillar 3126 diesel Power: 350 HP Suspension: 8x8 Wheeled, Hydropneumatic suspension Range: 450 Km Speed: 100 Km/h Origin: Canada	It can be used in many situations and the vehicle is a multi-roll combat vehicles.	It has a very strong armor, It has Hydropneumatic suspension and It is installed with a STANAG 4569 Level armor.	It produces less horsepower, It has very less range and it has less passenger accommodation and The armament is not powerful.

The vehicles stated above are the Armoured Non-Modular vehicles and they are one of the best in the segment. Now, let us see the Armoured Modular vehicles and they are as follows:



### III. PATRIA AMV

The Patria AMV is an Armored Modular Vehicle developed by the Finland Company Patria. The vehicle is also named after the Finnish defense industry company Patria. There is one main feature about this vehicle which makes it so special that is the Patria AMV has a modular design setup which permits it to have different battlement, weapons, sensors, or communication systems on the same body. The Patria AMV holds designs for different Armored Personnel Carrier (APC) vehicles and Infantry Fighting Vehicle (IFV) versions, communications versions, ambulances and different fire support vehicles, armed with large caliber mortar and gun system. The vehicle also protects from mine and can withstand explosions TNT capable of ten kilograms. The vehicle has a very high protection level up to 30mm APFSDS frontal arc and the significant characteristic of the Patria AMV is the good mobility in rough terrain with the rugged hydraulic suspension adjusting each wheel individually. [24][25]

The layout of the Patria AMV is divided into mainly three parts, the power pack at the front right, driver at the front left and the troop's compartment at the rear. A turret or weapon station can be mounted in the middle of the top hull. The Patria AMV is very spacious inside; it has an internal volume of 13 cubic meters which allows the vehicle to carry a driver, commander, gunner, and 8 troops, as a result of total 11 military personnel. Behind the driver position comes the commander hatch and two more large hatches at the back of the troop's section. The rear door is installed with one firing port and a small bulletproof window. The maximum payload that can be carried by the Patria AMV is about 13 tons and depending on the configuration, it has a combat weight of 16 tons to 30 tons. The Patria AMV's hull is made of welded steel structure which offers the crew and infantryman defence against firing of small arms and artillery shell splinters. The Patria AMC can be installed with an additional passive armor to increase the protection level. There is only a single hatch opening at the rear of the hull. The driver is provided with a day periscope on the front, which can be replaced by a passive night vision device. [24][26]The Patria AMV is powered with a Scania turbocharged diesel engine which produces 355 to 536 horsepower. The vehicle has two types of transmission, manual or ZF Ecomat 7HP902 automatic transmission with 7 forward and 1 reverse gears. The vehicle can be powered by variety of diesel engines; it depends on the customer's request. The Patria AMV has an 8x8 chassis with fully independent hydropneumatic suspension with double wishbone on every wheel. The Patria is also fully amphibious, it can take water up to 1.5m in depth without any preparation and the vehicle can swim at a speed from 8 to 10 km/h. The standard equipment installed in the Patria AMV includes a fire detection and suppression system, NBC protection system, air conditioning system, Central Tire Inflation System (CTIS), radios, intercom and night vision equipment. [24][27] The Patria Vehicles began to develop in the year 1996 and the Finnish Defense Forces (FDF) found that the 8x8 is the most suitable replacement

for their 6x6 Sisu Pasi. The first prototype from Patria on Armored Modular Vehicle was ready for testing in the year 2001. As a result of success, the Patria started manufacturing the AMV. There are different variants available, it was initially designed in 6x6, 8x8 and 10x10 variant was dropped lately.

The different variants of the Patria AMV are as follows: AMV Basic Platform, AMV High Roof Platform, AMV Heavy Weapon Platform, and Patria AMV XP. The Patria AMV XP is a next-generation 8x8 armored vehicle, the XP denotes for additional Payload, superfluous Performance, and Extra Protection. The Patria AMV costs around \$2.2 Million, on the whole, the vehicle is value for the money. Refer Fig. (9) and Fig. (10). [24] [28]



Figure 9 - Patria AMV with a remote weapon system;



Figure 10 - Patria AMV delivered to the UAE Army

## Armored Modular and Non-Modular Vehicle: A Survey

Specifications [24]	Uses	Advantages	Disadvantages
Weight: 16 to 27 Tons Length, Width & Height: 7.7 m, 2.8 m & 2.3 m. Crew: 3+12 Armor: All-Welded Steel Construction. Main Armament: Up to 105mm gun or twin 120 mm mortars in turret. Engine: DI 12 Scania Diesel or DC 12 Scania Diesel Power: 543 HP or 480 HP Suspension: 8x8 Wheeled, independent hydropneumatic suspension. Range: 600 to 850 Km Speed: 100 Km/h Origin: Finland	The Patria AMV can be used when there is a need of heavy weapon duty because it has got some powerful armaments mount on it.	High protection against mines and explosions like TNT, The vehicle is very spacious, Low cost compared to other AMV's and It can carry high payload.	The power produced in the vehicle is less, The armor is not strong compared to other AMV's and The vehicle is comparatively heavier.

### IV. BOXER

The Boxer is an Armored Fighting Vehicle which is also known as multi-role armored fighting vehicle because it has got different mission modules for different mission environment. This makes the Boxer most advance Armored Modular Vehicle (AMV) to till date. The mission modules can be installed on the vehicle anytime and anywhere. The Boxer designs consist of a wide-ranging protection system against ballistic threats ensure utmost crew safety. The vehicle can be personalized to meet up various undertaking necessities, in hastily changing conditions and comprehensive environments. The Armored Personnel Carrier (APC) variant of Boxer is played a vital role for the soldiers with multiple operations for network-based warfare. The Boxer APC can transport around 8 dismounts, in addition to driver, commander, and gunner. The Boxer is powered with an MTU model 8V199 TE20 diesel engine. The Boxer has an excellent on and off-road performance which is achieved by all-wheel drive. A Central Tire Inflation System (CTIS) is installed in the Boxer and run – flat inserts allow for 100 km of driving following deflation. The suspension in the Boxer is fully independent double wishbone type with coil springs. The Boxer achieves full performance under extreme environmental ad worst terrain conditions. The mission module of the boxer have feature of allowing the vehicle to quickly change to meet diverse operational necessities. The mission modules are as follows: Ambulance, Armored Personnel Carrier (APC), Battle Damage Repair, Cargo, Command Post, Engineer Group and Infantry Fighting Vehicle (IFV). An Airbus A400M tactical airlifter can deploy the Boxer and it can be deployed by road, train and also the sea. [29][30]

Most of the weapons equipped in the Boxer is installed in the company of a secluded weapon system for self-protection. The vehicle is fitted with verity of heavy machine guns and automatic grenade launcher. It has a weapon station named FLW-200 which consists of a laser rangefinder and a thermal imager, depending on the mission module. The protection on the Boxer is built from steel armor and a passive armor. The Boxer will endure large anti-tank mines or side attack. In the case of armor infiltration, the crew section is entirely covered by safety system named as AMAP-L which eventually increases survivability. To enhance the crew defense, the seats are decoupled from the floor, this will stop the distress of a mine-detonation. The roof armor in the Boxer is intended to endure artillery fragments and bomblets. [29][30][31]

The Boxer has a Rapid Strategic Mobility which is a combat-ready configuration and the vehicle includes fire snuff out system for the engine section. The Boxer could stay alive in nuclear explosion at medium distances. An integral navigation system with grenade launcher, camera is geared up in the Boxer. The Boxer has different variants and they are as follows: Boxer Command Post (Boxer CP), Boxer Ambulance (Boxer AMB), Boxer Geniegroep (Boxer GNGP), Boxer Cargo and Boxer Driver Training Vehicle (Boxer DTV). All the variants mentioned above are Dutch Variants. [29][30][32]

The Boxer is a German-Dutch vehicle and the project is running for Joint Armament Cooperation (OCCAR). The Boxer was designed to meet the latest battlefield standards and to have a next-generation vehicle so that the Germans can stay ahead in the race of development. The Boxer's unit cost is \$12,400,000. Refer Fig. (11) and Fig. (12). [29] [33]





Figure 11 - Boxer configured for Australian Land 400 Phase 2;



Figure 12 - A mission module of Boxer;

Specifications [29]	Uses	Advantages	Disadvantages
Weight: 24 Tons Length, Width & Height: 7.93 m, 2.99 m & 2.37 m Crew: Varies by role. In APC, 3+8. Armor: AMAP composite armor. Main Armament: Various, depends on configuration. Engine: MTU 8V199 TE20 Diesel rated at EURO 3 Power: 711 HP Suspension: Independent double wishbone coil (8x8). Range: 1,100 Km Speed: 103 Km/h Origin: Germany/Netherlands	The Boxer is suitable for any mission since it has got separate modules for separate missions and it will survive on the hardest battlefields.	Most Advanced AMV in the segment till date. It takes very less time to configure a mission module on to the vehicle and It has a long range compared to other vehicles.	High Cost, Less number of variants.

**V. HAVOC AMV**

The Havoc is an Armored Modular Vehicle which is still in the development phase. It is designed for the US Marine Corps' by the company called Lockheed Martin. The design of the Havoc AMV is based on the Finnish Patria AMV. The Havoc AMV is an extensive armored vehicle and it is available with wide range of configurations and it entirely lying on the necessities of the buyer. The Havoc has an ample variety of weapons are compatible and the main armament of one of the variant is fitted with a 12.7mm H2HB machine gun, a remote weapon system called M101 Raven and a 7.62mm M240g auxiliary machine gun. The Havoc's inner volume is 12.3 cubic meters, which can accommodate 2 crew members and 12 passengers. [34]The Havoc AMV is powered with a Scania DI 12 diesel engine which produces 540 horsepower and it has an 8x8 drive train with involuntary transmission. The vehicle's engine is

working on diesel or jet fuel and the operating temperature range is from -30 to +50 degree Celsius. The Havoc AMV

can reach speeds up to 105 km/h with a range around 900 km and the vehicle is completely operating on without any preparation, it can swim at a speed of 8 to 13 km/h. The Havoc AMV claimed that it be able to steer ocean waters by Sea State 2. [34] Havoc AMV has a wide range of protection features, together with blast protection and blast withstanding ability. The STANAG 4569 armor is composed of high-hardness steel, blacked with a suppression system. Wheels and tires of the Havoc AMV have a run-flat capability with speed limits 50 km by 10 km/h. The Havoc AMV uses a sub frame structure, rather than using a V-hull structure. The Havoc AMV is designed to solve one of the most difficult problems faced by the vehicles in the battlefield in the US Marine Corps'. The unit cost of the Havoc AMV is not released by the manufacturer. [34][35]

## Armored Modular and Non-Modular Vehicle: A Survey

Specifications [34]	Uses	Advantages	Disadvantages
Weight: 17 Tons Length, Width & Height: 7.74 m, 2.84 m & 2.38 m. Crew: Varies by role. In Base Model, 2+12. Armor: Composed of High-Hardness steel. Main Armament: In Base Model, 1x12.7mm, 1x7.62mm Machine Guns Engine: Scania DI 12 Diesel Engine. Power: 540 HP Range: 900 Km Speed: 105 Km/h Origin: USA	The Havoc can be used as Fully Amphibious Armored Personnel Carrier since it navigate through Sea State 2, which makes it one of the best AMV's in the segment.	Fully amphibious without and modification, The vehicle is lighter comparatively and The range is high for a vehicle which produces less horsepower.	It can carry only 2 crew members and The vehicle has less horsepower.

### VI. CONCLUSION

The survey report furnished above covers one of the best vehicles in its field. Both the Armored Modular Vehicle and Armored Non-Modular vehicles have their own advantages on each other. The reason for taking this survey is to show how far the developments of the Modular vehicles and Non-Modular vehicles have made and to bridge the gap between the vehicles. We hope that more countries should focus on Modular type of vehicle which more efficient and reliable than the Non-Modular vehicles. There is a future for the Modular Vehicles since the demand of Non-Modular vehicle is getting faded away. By the end of 2030 or 2040 we hope that almost all the countries will have Modular vehicles and we will be living in a modern era of technology. We propose that an armored vehicle with some updates mentioned earlier will satisfy all the requirements to be a Modular vehicle and try to win the globe.

### REFERENCE

1. [https://en.wikipedia.org/wiki/TATA\\_Kestrel](https://en.wikipedia.org/wiki/TATA_Kestrel)
2. <http://www.military-today.com/apc/kestrel.htm>
3. [https://www.militaryfactory.com/armor/detail.asp?armor\\_id=699](https://www.militaryfactory.com/armor/detail.asp?armor_id=699)
4. [https://www.armyrecognition.com/defexpo\\_2018\\_india\\_news\\_show\\_daily/new\\_whap\\_wheeled\\_amphibious\\_platform\\_8x8\\_armoured\\_at\\_defexpo\\_2018.html](https://www.armyrecognition.com/defexpo_2018_india_news_show_daily/new_whap_wheeled_amphibious_platform_8x8_armoured_at_defexpo_2018.html)
5. [https://www.armyrecognition.com/february\\_2018\\_global\\_defense\\_security\\_army\\_news\\_industry/u.s.\\_propose\\_to\\_india\\_to\\_develop\\_a\\_new\\_apc\\_armoured\\_personnel\\_carrier.html](https://www.armyrecognition.com/february_2018_global_defense_security_army_news_industry/u.s._propose_to_india_to_develop_a_new_apc_armoured_personnel_carrier.html)
6. <https://en.wikipedia.org/wiki/Stryker>
7. [https://en.wikipedia.org/wiki/M1126\\_Infantry\\_Carrier\\_Vehicle](https://en.wikipedia.org/wiki/M1126_Infantry_Carrier_Vehicle)
8. [https://en.wikipedia.org/wiki/M1127\\_Reconnaissance\\_Vehicle](https://en.wikipedia.org/wiki/M1127_Reconnaissance_Vehicle)
9. [https://en.wikipedia.org/wiki/M1128\\_Mobile\\_Gun\\_System](https://en.wikipedia.org/wiki/M1128_Mobile_Gun_System)
10. [https://en.wikipedia.org/wiki/M1129\\_Mortar\\_Carrier](https://en.wikipedia.org/wiki/M1129_Mortar_Carrier)
11. [https://en.wikipedia.org/wiki/M1130\\_Commander%27s\\_Vehicle](https://en.wikipedia.org/wiki/M1130_Commander%27s_Vehicle)
12. [https://en.wikipedia.org/wiki/M1131\\_Fire\\_Support\\_Vehicle](https://en.wikipedia.org/wiki/M1131_Fire_Support_Vehicle)
13. [https://en.wikipedia.org/wiki/M1132\\_EngineerSquad\\_Vehicle](https://en.wikipedia.org/wiki/M1132_EngineerSquad_Vehicle)
14. [https://en.wikipedia.org/wiki/M1133\\_Medical\\_Evacuation\\_Vehicle](https://en.wikipedia.org/wiki/M1133_Medical_Evacuation_Vehicle)
15. [https://en.wikipedia.org/wiki/M1134\\_Anti-Tank\\_Guided\\_Missile\\_Vehicle](https://en.wikipedia.org/wiki/M1134_Anti-Tank_Guided_Missile_Vehicle)
16. [https://en.wikipedia.org/wiki/M1135\\_Nuclear,\\_Biological,\\_Chemical,\\_Reconnaissance\\_Vehicle](https://en.wikipedia.org/wiki/M1135_Nuclear,_Biological,_Chemical,_Reconnaissance_Vehicle)
17. <https://en.wikipedia.org/wiki/BTR-90>
18. [http://www.military-today.com/apc/btr\\_90.htm](http://www.military-today.com/apc/btr_90.htm)
19. [https://www.militaryfactory.com/armor/detail.asp?armor\\_id=51](https://www.militaryfactory.com/armor/detail.asp?armor_id=51)
20. [https://www.forecastinternational.com/archive/disp\\_pdf.cfm?DACH\\_RECNO=1002](https://www.forecastinternational.com/archive/disp_pdf.cfm?DACH_RECNO=1002)
21. [https://en.wikipedia.org/wiki/LAV\\_III](https://en.wikipedia.org/wiki/LAV_III)

22. <http://www.military-today.com/apc/kodiak.htm>
23. <http://www.army-guide.com/eng/product1055.html>
24. [https://en.wikipedia.org/wiki/Patria\\_AMV](https://en.wikipedia.org/wiki/Patria_AMV)
25. [https://www.armyrecognition.com/finland\\_finnish\\_army\\_wheeled\\_armoured\\_vehicle\\_uk/amvpatria\\_wheeled\\_armoured\\_vehicle\\_technical\\_data\\_sheet\\_description\\_information\\_pictures\\_photos\\_uk.html](https://www.armyrecognition.com/finland_finnish_army_wheeled_armoured_vehicle_uk/amvpatria_wheeled_armoured_vehicle_technical_data_sheet_description_information_pictures_photos_uk.html)
26. [http://www.military-today.com/apc/patria\\_amv.htm](http://www.military-today.com/apc/patria_amv.htm)
27. <https://www.army-technology.com/projects/patria/>
28. [http://www.deagel.com/Armored-Vehicles/AMV-8x8\\_a000585001.aspx](http://www.deagel.com/Armored-Vehicles/AMV-8x8_a000585001.aspx)
29. [https://en.wikipedia.org/wiki/Boxer\\_\(armoured\\_fighting\\_vehicle\)](https://en.wikipedia.org/wiki/Boxer_(armoured_fighting_vehicle))
30. [https://www.armyrecognition.com/germany\\_german\\_army\\_wheeled\\_armoured\\_vehicle\\_uk/boxer\\_mrav\\_multi\\_role\\_armoured\\_vehicle\\_technical\\_data\\_sheet\\_specifications\\_description\\_pictures.html](https://www.armyrecognition.com/germany_german_army_wheeled_armoured_vehicle_uk/boxer_mrav_multi_role_armoured_vehicle_technical_data_sheet_specifications_description_pictures.html)
31. [http://www.military-today.com/apc/boxer\\_mrav.htm](http://www.military-today.com/apc/boxer_mrav.htm)
32. <https://www.army-technology.com/projects/mrav/>
33. <https://www.defenseindustrydaily.com/the-fighter-still-remains-dutch-to-continue-with-boxer-apc-program-updated-02410/>
34. <http://www.military-today.com/apc/havoc.htm>
35. <https://www.army-technology.com/projects/havoc-8x8-armoured-modular-vehicle/>

### AUTHORS PROFILE



**M. Sheik Dawood** received his M.E Degree from Madurai Kamaraj University, Tamilnadu, India and completed his Ph.D. in Information and Communication Engineering at Anna University, Tamilnadu, India. His research interests include IoT, Energy efficient Sensor Network Protocol development, Wireless communication and Network security.



**A. Fardhan Ahmed**, UG Scholar (Electronics and Communication) at Sethu Institute of Technology, Tamilnadu, India. Research interest in Quantum Physics, AI & Machine learning, Astrophysics and Wireless Communication.



**M. Jehosheba Margaret** received her B.E. Electronics and Communication Engineering from Ponnaiyah Ramjayam College of Engineering and Technology, Tamilnadu, India and M.E. VLSI Design from Kings College of Engineering, Tamilnadu, India in the year 2014. Her research interests include Network on Chip, Wireless Communication and IOT.





**C. Yesubai Rubavathi** received her M.E Degree and Ph.D. in Anna University, Tamilnadu, India. Her research interest Image processing, IoT, Wireless Communication and Network Security.