

MOTORCYCLES

Overall Trends

1 Introduction

In 2022, motorcycle production in Japan increased by 7.4% from 2021 to 695,000 units. Exports also increased by 11.4% to 487,000 units, the second successive year-on-year increase after the declines caused by the effects of the COVID-19 pandemic that started in 2019. In contrast, the number of motorcycles shipped inside Japan fell by 4.5% to 362,000 units.

2 Production and Demand Trends

2.1. Production

As shown in Fig. 1, the number of motorcycles produced in Japan in 2022 increased by 7.4% from 2021 to a total of 695,000 units. Exports increased by 11.4% to 487,000 units, while shipments inside Japan fell 7.4% to 362,000 units.

2.2. Demand in Japan

Figure 2 shows motorcycle demand in Japan based on engine displacement. Whereas demand fell for class 2 motor-driven cycles and mini-sized motorcycles, demand rose for class 1 motor-driven cycles and small-sized motorcycles. As a result, overall demand fell by 4.5% to 362,000 units compared to 2021.

(1) 50 cm³ or Less Displacement Motorcycles (Class 1 Motor-Driven Cycles)

In 2022 the demand for this class of motorcycles increased by 2.3% from the previous year to 131,000 units.

(2) 51 to 125 cm³ Displacement Motorcycles (Class 2 Motor-Driven Cycles)

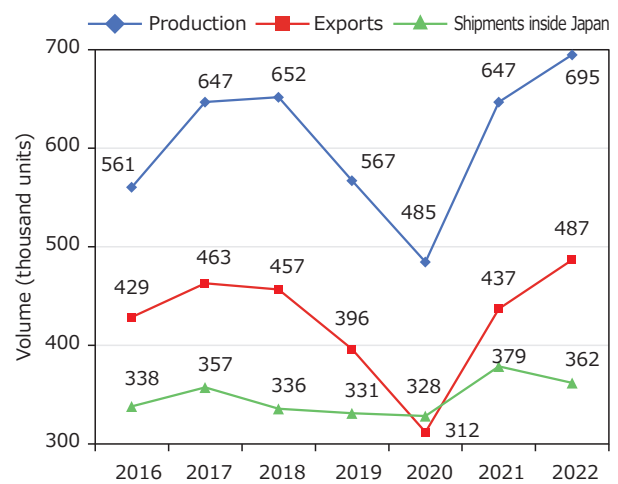
In 2022, the demand for this class decreased by 19.0% from the previous year to 102,000 units.

(3) 126 to 250 cm³ Displacement Motorcycles (Mini-Sized Motorcycles)

In 2022 the demand for this class of motorcycles decreased by 14.9% from the previous year to 57,000 vehicles.

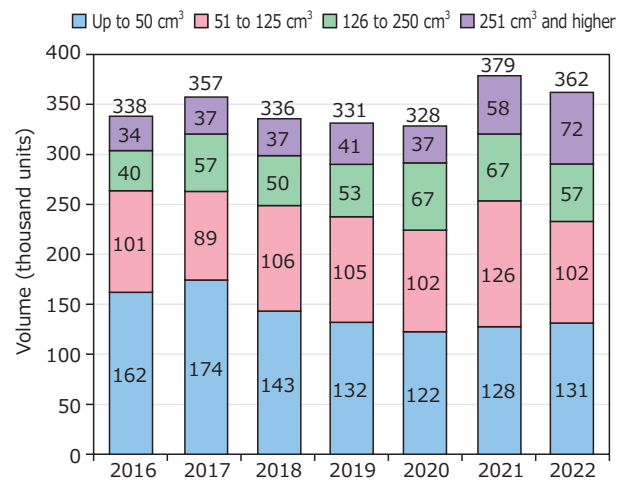
(4) 251 cm³ or Higher Displacement Motorcycles (Small-Sized Motorcycles)

In 2022 the demand for this class of motorcycles increased by 24.1% from the previous year to 72,000 vehicles.



* Source: publicly available database of the Japan Automobile Manufacturers Association

Fig. 1 Trends for Production, Exports, and Shipments inside Japan



* Source: publicly available database of the Japan Automobile Manufacturers Association

Fig. 2 Shipments inside Japan based on Engine Displacement

2. 3. Exports

In 2022, exports to all regions other than Asia and Oceania rose due to higher motorcycle demand for personal transportation and leisure, triggered by the global COVID-19 pandemic, as well as post-pandemic economic recovery, increasing by 11.4% to 487,000 units compared to 2021 (Fig. 3). In contrast, exports to Asia fell by 6.2% and exports to Oceania fell by 12.9%.

(1) North America

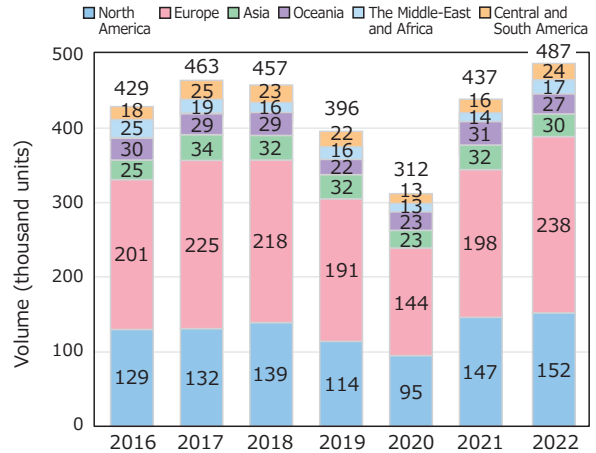
Motorcycle exports to North America in 2022 increased by 3.4% from the previous year to 152,000 units.

(2) Europe

Motorcycle exports to Europe in 2022 increased by 20.2% from the previous year to 238,000 units.

(3) Asia

Motorcycle exports to Asia in 2022 decreased by 6.2%



* Source: publicly available database of the Japan Automobile Manufacturers Association

Fig. 3 Shipments per Market

Table 1 Details of Main New Motorcycles Launched in 2022

Month of launch	New	Redesigned	Manufacturer	Name of model	Characteristics
January		○	Kawasaki	Vulcan S	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	SV650 ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Suzuki	SV650 X ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Honda	CBR400 R	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Honda	400 X	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Honda	Rebel 250 S Edition	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CBR250 RR	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Honda	Giorno	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Dunk	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	CT125 Hunter Cub	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	CRF1100 L Africa Twin Adventure Sports ES	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Yamaha	YZF-R1 M ABS	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R1 ABS	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
	February		○	Kawasaki	Ninja ZX-25 R SE
○			Kawasaki	KLX230 S	Air-cooled/4 -stroke/single-cylinder/DOHC/2 -valve/FI
		○	Yamaha	FJR1300 AS/A	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R7 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Cygnus Gryphus WGP 60 th Anniversary	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
○			Suzuki	GSX-S1000 GT	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	Katana	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R1 ABS WGP 60 th Anniversary	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
	○	Yamaha	YZF-R1 Race Base model	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI	
	○	Yamaha	YZF-R6 Race Base model	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI	
March		○	Honda	CBR1000 RR-R Fireblade/SP	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R7 ABS WGP 60 th Anniversary	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Axis Z	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	Lead 125	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
	○		Honda	NT1100	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Suzuki	V-Strom1000 650 XT ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
April		○	Yamaha	XSR700 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Vino	Liquid-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	Super Cub 110	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Cross Cub 110	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	CRF1000 L Africa Twin	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Honda	Gold Wing	Liquid-cooled/4 -stroke/horizontally opposed 6 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Honda	Gold Wing Tour	Liquid-cooled/4 -stroke/horizontally opposed 6 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Kawasaki	Ninja H2 SX	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI/supercharged
		○	Suzuki	V-Strom 650 ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Suzuki	GSX-S125 ABS	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI

Table 1 Details of Main New Motorcycles Launched in 2022 (Cont.)

Month of launch	New	Redesigned	Manufacturer	Name of model	Characteristics
May		○	Honda	Super Cub 110 Pro	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	CRF1100 L Africa Twin<s>	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Honda	CRF1100 L Africa Twin Adventure Sports ES<s>	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Yamaha	Ténéré 700 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT-07 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT-25 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R25 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	NMAX155 ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
June		○	Honda	CBR1000 R	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R3 ABS WGP 60 th Anniversary	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Honda	PCX	Air-cooled/4 -stroke/single-cylinder/OHC/4 -valve/FI
		○	Honda	PCX160	Air-cooled/4 -stroke/single-cylinder/OHC/4 -valve/FI
		○	Honda	Super Cub 50	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Super Cub 50 Pro	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Cross Cub 50	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Yamaha	X Force ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
	○	Yamaha	XSR900	Liquid-cooled/4 -stroke/inline 3 -cylinder/DOHC/4 -valve/FI	
	○	Suzuki	Hayabusa	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI	
July		○	Yamaha	MT-09 ABS	Liquid-cooled/4 -stroke/inline 3 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	TMAX560 Tech Max ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	TMAX560 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 1000 SX	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	Dax 125	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	CB250 R	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	NC750L (manual transmission instructional vehicle spec.)	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC/4 -valve/FI
		○	Honda	NC750L (automatic transmission instructional vehicle spec.)	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC/4 -valve/FI
		○	Suzuki	GSX-S125 ABS	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Suzuki	GSX-R125 ABS	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○	Honda	X-ADV	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC (uni-cam)/4 -valve/FI	
	○	Honda	Dio 110	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI	
August		○	Kawasaki	Meguro K3	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
		○	Kawasaki	W800	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
September		○	Kawasaki	KX112	Liquid-cooled/2 -stroke/single-cylinder/piston reed valve/carburetor
		○	Kawasaki	KX250	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX250 X	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX450	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KLX110 RL	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/carburetor
		○	Kawasaki	KLX230 R	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	KLX230 R S	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	Z900 RS Cafe	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	XMAX ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Honda	CRF50 F	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/carburetor
		○	Honda	CRF110 F	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	CRF125 F	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Hawk 11	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC (uni-cam)/4 -valve/FI
		○	Kawasaki	Z400	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 400 KRT Edition	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
	○	Suzuki	RM-Z450	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI	
	○	Suzuki	RM-Z250	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI	
	○	Yamaha	NMAX ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI	
	○	Yamaha	E-Vino	AC synchronous motor	
October		○	Kawasaki	Ninja ZX-6 R KRT Edition	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	DR-Z50	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/carburetor
		○	Honda	CRF450 R	Liquid-cooled/4 -stroke/single-cylinder/OHC (uni-cam)/4 -valve/FI
		○	Honda	CRF450 RX	Liquid-cooled/4 -stroke/single-cylinder/OHC (uni-cam)/4 -valve/FI
		○	Kawasaki	Versys-X 250 Tourer	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KLX230 SM	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Address 125	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Avenis 125	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	MT-10	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT-10 SP	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZ125 X	Liquid-cooled/2 -stroke/single-cylinder/reed valve/carburetor
		○	Yamaha	YZ250 X	Liquid-cooled/2 -stroke/single-cylinder/reed valve/carburetor
	○	Yamaha	PW50	Air-cooled/2 -stroke/single-cylinder/reed valve/carburetor	
	○	Yamaha	YZ450 F	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI	

Table 1 Details of Main New Motorcycles Launched in 2022 (Cont.)

Month of launch	New	Redesigned	Manufacturer	Name of model	Characteristics
November	○	○	Kawasaki	Z650 RS	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z900	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Jog 125	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	TT-R125 LWE	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/carburetor
		○	Yamaha	TT-R110 E	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/carburetor
December		○	Yamaha	Gear BX50 (Gear)	Liquid-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Yamaha	Gear BX50 N (News Gear)	Liquid-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Yamaha	Gear BX50 S (Gear Parking Stand)	Liquid-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Honda	CT125 Hunter Cub	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	CB1300 Super Four SP	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CB1300 Super Four Bol D'Or SP	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CB1300 Super Four SP 30 th Anniversary	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CB1300 Super Four Bol D'or SP 30 th Anniversary	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	Rebel 250	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	Rebel 250 S Edition	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	Forza	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI

from the previous year to 30,000 units.

(4) Oceania

Motorcycle exports to Oceania in 2022 decreased by 12.9% from the previous year to 27,000 units.

(5) The Middle-East and Africa

Motorcycle exports to the Middle East and Africa in 2022 increased by 21.4% from the previous year to 17,000 units.

(6) Central and South America

Motorcycle exports to Central and South America in 2022 increased by 50.0% from the previous year to 24,000 units.

3 Product and Technological Trends

3.1. Product trends

Table 1 lists some of the representative motorcycle models launched in Japan in 2022.

Although no class 1 motor-driven cycles debuted in 2022, redesigned versions of models such as the Honda Giorno, Dunk, and Super Cub, as well as the Yamaha Vino, E-Vino, and Gear BX50 were launched. New class 2 motor-driven cycle models included the Honda Dax 125, the Suzuki Avenis 125, and the Yamaha Jog 125. In the same category, redesigned versions of models such as the Honda CT125, Lead 125, Super Cub 110, PCX160, and Dio 110, the Yamaha Axis Z and NMAX ABS, as well as the Suzuki GSX-S125 ABS and Address 125 were launched.

New mini-sized motorcycle models included the Kawasaki KLX230S and KLX230-SM, as well as the Yamaha X Force ABS. In the same category, redesigned models such as the Honda Rebel 250, CBR250RR, CB250R, and Forza, the Yamaha MT-25 ABS, YZF-R25 ABS,

NMAX155, and XMAX ABS, the Suzuki RM-Z250, as well as the Kawasaki Ninja ZX-25R and Versys-X 250 Tourer were launched.

New small-sized motorcycle models included the Honda Hawk 11 and the Suzuki GSX-S1000GT. In the same category, redesigned models such as the Honda CBR400R, 400X, CRF1100L Africa Twin Adventure Sports ES, CBR1000RR-R Fireblade, Gold Wing, CBR1000R, NC750L, X-ADV, and CB1300, the Yamaha YZF-R1 ABS, YZF-R6, YZF-7 ABS WGP 60th Anniversary, FJR1300AS, XRS900, MT-10, MT-09 ABS, and TMAX650, the Suzuki SV650ABS, Katana, V-Strom 650 ABS, Hayabusa, and RM-Z450, as well as the Kawasaki Vulcan S, Ninja H2 SX, Ninja 1000SX, Meguro K3, W800, Z900RS Cafe, Z400, Ninja 400 KRT Edition, Ninja ZX-6R KRT Edition, Z650RS, and Z900 were launched.

3.2. Technological trends

Although electric motorcycles are attracting a great deal of attention as a new technological trend, the number of models did not increase since no new models were launched in 2022. However, five companies, ENEOS Holdings, Inc., Honda Motor Co., Ltd., Kawasaki Motors Corporation, Suzuki Motor Corporation, and Yamaha Motor Co., Ltd., came together to establish a company called Gachaco on April 1, 2022, with the aim of providing sharing services for motorcycle batteries with common specifications and establishing electric infrastructure. This should help encourage the wider adoption of electric motorcycles with common battery specifications. Other technological trends for mini-sized motorcycles saw the launch of models equipped with mobile terminal connectivity functions, as well as models equipped with emergency stop signal functions to rapidly communicate to

trailing vehicles that the rider has braked abruptly. These functions are likely to be expanded to all motorcy-

cle categories in the future.

Engines

1 Technological Trends in Japan

1.1. Overview

Table 1 lists the specifications of the engines equipped on the major new motorcycle models that went on sale from Japanese manufacturers in 2022. This year saw the development and refinement of engines to improve performance and handling by, for example, enabling the selection of power characteristics in accordance with rider preference, while also complying with the emissions regulations that were enacted in 2021.

1.2. Trends of Each Manufacturer

(1) Honda Motor Co., Ltd.

(a) NT1100

The NT1100 features a 1,082 cm³ liquid-cooled 4-stroke inline 2-cylinder SOHC 4-valve engine adopting the same 270-degree phased crankshaft as the CRF1100L. This model also features a specially designed intake and exhaust system that helps deliver usable torque from low engine speeds and smooth characteristics up to high rpms. By providing a dual clutch transmission (DCT) as standard equipment and adopting automatic gear shifting, the NT1100 enables a secure and confident riding experience. The NT1100 is also equipped with a range of rider-supporting electronic controls such as a throttle-by-wire (TBW) system, riding modes with different power characteristics, and the Honda Selectable Torque Control (HSTC) system that suppresses lifting of the front wheel and rear-wheel slip. Figure 1 shows the external appearance of this motorcycle.

(b) Super Cub 110 Pro

The Super Cub 110 Pro features a 109 cm³ air-cooled 4-stroke single-cylinder OHC 2-valve engine. Compliance with the 2020 emissions regulations was achieved by reducing the bore diameter from 50 to 47 mm, lengthening the stroke from 55.6 to 63.1 mm, and raising the compression ratio from 9.0:1 to 10.0:1. These measures also helped to increase maximum torque by 0.3 Nm to 8.8 Nm while maintaining the same maximum power as the outgoing model of 5.9 kW. As a result, fuel economy under the Worldwide Harmonized Motorcycle Emissions Certification Procedure (WMTC) improved by 0.4 km to 67.4

km/L, while further enhancing rider-friendliness. Figure 2 shows the external appearance of this motorcycle.

(2) Yamaha Motor Co., Ltd.

(a) YZ450F

The YZ450F features a 449 cm liquid-cooled 4-stroke single-cylinder DOHC 4-valve engine. Changes include the adoption of a dry sump, as well as a lighter piston and crankshaft assembly, resulting in a 500 rpm higher rev limit compared to the previous model. The diameter of the titanium intake valve was increased from 37 to 39 mm and a double machining process was adopted to optimize the slot shape of the intake port, improving the intake air volume by 9% at maximum valve lift. In addition to higher engine speed, power was also improved by 5%. An integrated steel primary gear and housing structure was combined with a disc clutch spring to reduce the weight of the clutch assembly from 3.14 to 2.39 kg. The stand-alone weight of the engine was also reduced by 1.1 kg. Figure 3 shows the external appearance of this motorcycle.

(b) NMAX155

The NMAX155 features a 155 cm³ liquid-cooled 4-stroke single-cylinder SOHC 4-valve engine. A new cylinder head was adopted alongside a newly designed lightweight forged piston, resulting in a more compact combustion chamber that increases the compression ratio from 10.5:1 to 11.6:1 and realizes more efficient combustion. At the same time, intake efficiency was also improved by expanding diameter of the intake valve from 19.5 to 20.5 mm and adopting a high-volume air cleaner box. Combined with variable valve actuation (VVA), these refinements help to realize both an agile acceleration feeling and linear response. Adoption of the Smart Mode Generator (SMG) helps to realize quieter performance at start, and a start-stop system helps to raise fuel economy under WMTC conditions by 7%. Figure 4 shows the external appearance of this motorcycle.

(3) Suzuki Motor Corporation

(a) GSX-S1000GT

The GSX-S1000GT features a 998 cm liquid-cooled 4-stroke inline 4-cylinder DOHC 4-valve engine with the same bore (73.4 mm) and stroke (59 mm) dimensions as

Table 1 Specifications of New Engines in 2022

Manufacturer	Name of model	Engine type	Displacement (cm ³)	Bore (mm)	Stroke (mm)	Maximum power (kW/rpm)	Max. torque (N · m/rpm)
Honda	NT1100	Liquid-cooled/4 -stroke/inline 2 -cylinder/SOHC/4 -valve	1,082	92	81.4	75 /7,500	104 /6,250
	Super Cub 110 Pro	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve	109	47	63.1	5.9 /7,500	8.8 /5,500
Yamaha	YZF450 F	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve	449	97	60.8	N.A	N.A
	NMAX155	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve	155	58	58.7	11 /8,000	14 /6,500
Suzuki	GSX-S1000 GT	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve	998	73.4	59	110 /11,000	105 /9,250
	Address 125	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve	124	52.5	57.4	6.4 /6,750	10 /5,500
Kawasaki	Z650 RS	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve	649	83	60	50 /8,000	63 /6,750
	KX250	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve	249	78	52.2	N.A	N.A

**Fig. 1** NT1100**Fig. 2** Super Cub 110 Pro**Fig. 3** YZF450F**Fig. 4** NMAX155**Fig. 5** GSX-S1000GT**Fig. 6** Address 125

the GSX-S1000 launched in 2021. Combined with electronic controls, optimum torque delivery is realized by precise engine control. This model is equipped with an electronically controlled throttle and the Suzuki Drive Mode Selector (SDMS) system, allowing the rider to select the preferred riding mode under a wide range of riding conditions. Figure 5 shows the external appearance of this motorcycle.

(b) Address 125

The Address 125 features a 124 cm forced air-cooled 4-stroke single-cylinder SOHC 2-valve engine. While maintaining the same basic specifications as the 2021 model, higher combustion efficiency and lower friction loss helps to achieve the maximum torque of 10 Nm at a lower engine speed of 5,500 rpm compared to 6,000 rpm in the previous model. As a result, fuel economy under WMTC conditions was improved by 5.5% to 53.8 km/L while complying with the 2020 emissions regulations. Figure 6 shows the external appearance of this motorcy-

cle.

(4) Kawasaki Motors Corporation

(a) Z650RS

The Z650RS features a 649 cm liquid-cooled 4-stroke parallel 2-cylinder DOHC 4-valve engine. Adopting the same throttle diameter as the Z650 (36 mm) realizes powerful performance in low to middle engine speed ranges and excellent throttle response. This model is also equipped with a sub throttle valve to realize smooth and highly precise throttle control. In addition, Kawasaki's Assist & Slipper® Clutch system creates a lighter and smoother clutch lever operation feeling and helps to suppress hopping and slipping of the rear tire when excessive engine braking is applied, resulting in even greater controllability. Figure 7 shows the external appearance of this motorcycle.

(b) KX250

The KX250 features a 249 cm liquid-cooled 4-stroke single-cylinder DOHC 4-valve engine. While maintaining



Fig. 7 Z650RS



Fig. 8 KX250



Fig. 9 K1600GTL



Fig. 10 Panigale V4



Fig. 11 Tiger 1200 GT Pro



Fig. 12 RC390

the bore diameter (78 mm), stroke (52.2 mm), and compression ratio (14.1:1) of the previous model, the intake valve pitch was narrowed from 37 to 35.5 mm, and the valve diameter was reduced from 32 to 31 mm. Other modifications include the adoption of a straighter down-draft intake duct and the repositioning of the upstream injector of the dual injector system from the top to the bottom of the duct. These modifications help to improve intake efficiency into the cylinder and raise peak performance. In the exhaust system, the length of the exhaust header pipe was changed from 457 to 557 mm, helping to increase torque in the low- and mid-rpm ranges. Easy-to-handle racing power characteristics were realized by changing the moment of inertia of the flywheel from 9.5 to 10.0 kg-cm². Figure 8 shows the external appearance of this motorcycle.

2 Technological Trends outside Japan

(1) BMW K1600GTL

The K1600GTL features a 1,648 cm liquid-cooled 4-stroke parallel 6-cylinder DOHC 4-valve engine that adopts the same specifications as the 2021 model including a bore diameter of 72 mm, a stroke of 67.5 mm, and a compression ratio of 12.2:1. While complying with the mandatory Euro 5 standards, this model generates the same maximum power as the previous model (118 kW) at a lower engine speed (6,750 rather than 7,750 rpm) and maximum torque was raised from 175 to 180 Nm. Engine

drag control by BMW's Digital Motor Electronics (DME) engine management system is specifically optimized for performance and touring while ensuring stability and safety. Figure 9 shows the external appearance of this motorcycle.

(2) Ducati Panigale V4

The Panigale V4 features a 1,103 cm liquid-cooled 4-stroke V4 DOHC 4-valve engine with a bore diameter of 81 mm, a stroke of 53.5 mm, and a compression ratio of 14.0:1. Maximum power was raised by 1.1 kW to 158.5 kW by expanding the exhaust silencer outlet to 38 mm, lowering the exhaust pressure, and reducing friction by revising the oil passages to reduce oil pump volume. A new gear box was adopted for riders with a preference for racing performance. This gear box features the same gear ratios as motorcycles competing in the Superbike World Championship (SBK) by raising the ratio of first gear by 11.6% and second gear by 5.6%. Figure 10 shows the external appearance of this motorcycle.

(3) Triumph Tiger 1200 GT Pro

The Tiger 1200 GT Pro features a newly designed 1,160 cm liquid-cooled 4-stroke parallel 3-cylinder DOHC 4-valve engine. The bore diameter was increased from 85 to 90 mm and the stroke reduced from 71.4 to 60.7 mm. Although total displacement fell from 1,215 to 1,160 cm, the compression ratio was raised from 11.0:1 to 13.2:1, maximum power increased by 6.6 kW to 110.4 kW, and maximum torque increased by 8 kN to 130 Nm. This

model is equipped with multi-point sequential electronic fuel injection and an electronically controlled throttle, and allows the rider to select between a maximum of six types of riding modes based on preference and terrain. Figure 11 shows the external appearance of this motorcycle.

(4) KTM RC390

The RC390 features a 373 cm liquid-cooled 4-stroke single-cylinder DOHC 4-valve engine that shares the same basic specifications as the engine in the 390 Duke that was launched in 2021. This model is equipped with a larger capacity air cleaner box, electronically controlled throttle, and traction control. The clutch also features a back torque limiter called an anti-hopping clutch that suppresses unnecessary chattering during riding to en-

hance controllability. Figure 12 shows the external appearance of this motorcycle.

3 Research and Development Trends

In 2022, each manufacturer launched new models with improved performance that also comply with the Euro 5 emissions standards. In response to the global environmental trend toward carbon neutrality, active research and development were carried out into electrification, the adoption of renewable energy, and decarbonization, with these efforts transitioning toward the practical implementation phase. With rising demand for even greater environmental friendliness, it is hoped that this research will translate into the development of products that meet both market and user needs.

❖❖❖❖❖❖❖❖ Design Trends ❖❖❖❖❖❖❖❖

1 Introduction

Each year in November, Milan, Italy, plays host to the Esposizione Internazionale Ciclo Motociclo e Accessori (EICMA), the world's largest motorcycle show. In 2022, EICMA finally showed signs of returning to pre-pandemic levels. The number of people surrounding new models and the general maskless state of visitors were quite remarkable (Fig. 1).

EICMA featured a greater presence from Chinese and Indian manufacturers, and showcased the accelerating technological development in connected, autonomous, shared, and electric (CASE) fields, alongside a wide range of proactive approaches toward achieving carbon neutrality.

Figure 2 illustrates various motorcycle trends in Europe. The COVID-19 pandemic underlined the necessity for personal mobility and may be seen as a watershed moment providing particular impetus to motorcycle demand. However, the growing severity of the recent disruption to the global semiconductor supply chain has had a severe impact on motorcycle production.

Current trends highlight the domination of naked models, motorcycles capable of being ridden both on- and off-road, and compact motorcycles, and manufacturers are likely to concentrate on these categories in the future. This section looks back on the design trends for new models released in 2022 with a particular focus on these popular categories.



Fig. 1 Crowds at EICMA (Ducati Booth)

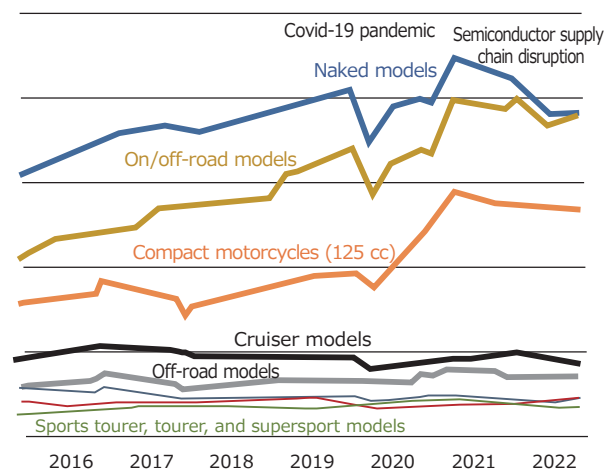


Fig. 2 European Motorcycle Trends (Source: Honda)

2 Evolution of the Most Popular Naked Category

In the European market, highly versatile naked motorcycles are seen as popular mid-range entry models. Debuting in 2022, the Honda CB750 Hornet (Fig. 3) features a glamorous exterior appearance that expresses both agility and power. The Suzuki GSX-8S (Fig. 4) is equipped with extended shrouds that seem to wrap around each side, creating a fresh-looking mass-forward silhouette with a refined surface expression. Both models are built on a lightweight low-cost platform featuring a parallel 2-cylinder engine and simple chassis structure, combined with next-generation styling designed to appeal to younger riders as well as corporate color schemes expressed through the frame and functional parts. Additionally, the top grades of both models also feature a full-color TFT instrument cluster.

At the same time, in a higher price bracket, 2022 also saw pronounced advances in design led by aerodynamic technology, as typified by the MotoGP-inspired Ducati Desmosedici GP (Fig. 5). From 2016, unique winglets started to become a significant feature in MotoGP, and this trend has now become firmly established in naked models.

The Ducati Streetfighter V4 (Fig. 6) and BMW M1000R (Fig. 7) have prominent winglets extending from the left and right sides that enhance dynamic performance by making use of downforce, while also creating a striking external appearance. The Ducati Diavel V4 has an iconic and massive silhouette that seems to translate power



Fig. 3 Honda CB750 Hornet



Fig. 4 Suzuki GSX-8S



Fig. 5 Ducati Desmosedici GP



Fig. 6 Ducati Streetfighter V4 S



Fig. 7 BMW M1000R



Fig. 8 Ducati Diavel V4

into visual form (Fig. 8). It features beautiful details that fuse functionality with playfulness. The imposing intakes and daytime running lights (DRL) create a distinct front mask, and the taillight provided under the upturned cowl stands out conspicuously.

3 Diversifying Crossover Concepts

The adventure segment has grown to equal the number of models in the popular naked category. Although this segment had mainly focused on higher price models in terms of available specifications, 2022 saw a succession of releases in the middle range. The Honda Transalp (Fig. 9) and Suzuki V-Strom 800-DE (Fig. 10) were developed at the same time as the naked models described in the previous section. Emphasizing off-road capabilities, both models are equipped with 21- and 17-inch tires at the front and rear, respectively. At the same time, the use of shared platforms provides excellent cost performance. The Transalp features a dignified appearance that expresses both durability and agility, combining welcoming familiarity with an adventurous spirit. In contrast, the V-Strom 800-DE retains its iconically sharp and agile high “beak” styling. At a higher price point in the same segment, 2022 also saw true diversification in the market as competition for the segment leader, the BMW R1250GS. The Triumph Tiger 1200 (Fig. 11) combines Triumph’s legendary 3-cylinder engine with an expanded range of safety devices such as millimeter wave radar and touring equipment, as well as a powerful external appearance that suggests a real sense of adventure.



Fig. 9 Honda Transalp **Fig. 10** Suzuki V-Strom 800-DE



Fig. 13 Yamaha Tracer 9 GT **Fig. 14** Honda NT1100



Fig. 11 Triumph Tiger 1200



Fig. 12 Harley Davidson Pan America 1250

Harley Davidson, the long-established leader of traditional American style, released the Pan America 1250 (Fig. 12). This model features “beakless” styling with a high front fender and draws a direct line from European models. The horizontal tone of its appearance extending out from the V2 engine and the rectangular LED headlight are unique characteristics. Based on the MT-09, the Yamaha Tracer 9 GT is a sports tourer with enhanced on-road performance and versatile applicability (Fig. 13). The technical advances of this model also attracted attention. It is equipped with position lights that line up with the headlight and space-efficient cornering lights, as well as millimeter wave radar mounted in the front end. It has a unique and stylish design that collects these cutting-edge devices into a nimble package. The Honda NT1100 was developed based on the CRF1100L platform (Fig. 14). It features a five-level manually height-adjustable windscreen and fairings with excellent wind-shielding performance, packaging the functionality of a tourer into an elegantly styled model. Over the last few years, adventure bike styling has become the mainstream.

However, technical innovations and crossover models are becoming more and more diverse.

4 Rapid Rise of Chinese and Indian Manufacturers

One particular trend of recent years has been the rapid development and rise of Chinese and Indian manufacturers in terms of design maturity, product appeal, and cost performance. These manufacturers have deepened their capital, development, and production ties with leading European brands, and have the technological capabilities to speedily realize fashionable styling trends. The growth of these manufacturers is accelerating as information technology and large investment become more important. Chinese and Indian manufacturers are leading the way in the 125 cc class that is the entry point for many younger riders, and are likely to move into the medium and larger segments in the future. The Benelli TRK502 (Fig. 15) and RKF125 (Fig. 16) are two typical examples. These models perfectly reflect the European trends described in the previous sections and have an extremely high level of quality even at a micro level. Japanese manufacturers already regard these manufacturers as a clear threat.

The orthodox version of the Royal Enfield Meteor 350 (Fig. 17) has great appeal due to its simple and attractive external appearance. Variations built on the same platform are also of a very high standard. The Interceptor 650 (Fig. 18) features a traditional frame finished with unornamented metal parts and bright chrome, and appeals strongly to motorcycle fans. Combined with promotions designed to arouse customer curiosity through apparel and accessories, this model has enough quality to spark the interest of potential users. It is no exaggeration to say that the marketing skills of Chinese and Indonesian manufacturers are equal to or even higher than manufacturers in developed countries.



Fig. 15 Benelli TRK502



Fig. 16 Benelli RKF125



Fig. 17 Royal Enfield Meteor 350



Fig. 18 Royal Enfield Interceptor 650

5 Issues of Highly Functional HMI and GUI

There is still a large portion of older riders who have always preferred needles and analog gauges. However, as electronic controls advance and become more functional, more models are adopting color TFT instrument clusters capable of displaying large volumes of information. Accompanying the development of Apple CarPlay and Android Auto, graphical user interface (GUI) design is continuing to grow in importance. In addition to allowing users to select automatic dimming and background colors as a matter of course, TFT monitors also enable the layout of displays to be changed in accordance with the scenario. The user friendliness of these instruments is steadily increasing as demonstrated by Smart phone Bluetooth connectivity and built-in voice recognition. The excellent legibility of these monitors is partially realized by a steady increase in screen size. As a result, the imposing nature of these instruments located at the end of the chassis is having a major effect on overall motorcycle proportions. For this reason, GUI need to be redesigned to realize sufficient legibility within a smaller package. Another byproduct of the growing complexity of menus within these displays is an increase in the number of buttons and switches on the handlebars. Another issue for manufacturers is, therefore, the development of more advanced operating systems that ensure both a safe and intuitive riding experience.

6 Toward Carbon Neutrality

The electrification of motorcycles involves the creation of new industrial designs different from what has come before. Meeting this challenge is the mission of the next generation of designers. At EICMA in 2022, Kawasaki showcased an electric model it plans to launch on the market, a prototype hybrid electric motorcycle, and a concept model equipped with a hydrogen engine as potential options for alternative energy-powered products for the future (Fig. 19).

Livewire, the dedicated electric motorcycle brand spun off from the legacy manufacturer Harley Davidson, presented the S2-Del Mar (Fig. 20). With a silhouette resembling a street scrambler, the S2-Del Mar has an innovative design that retains a motorcycle-like appearance while expressing the functionality and aesthetics typical of an electric model. Lacking a traditional frame, the battery case is designed to function as a strengthening member, creating a slim and compact package with the potential to be adopted on a wide range of models. The Ola Electric S1 attracted attention in the electric scooter category (Fig. 21). This model features an underfloor battery, link mechanism front and rear suspensions, and a sophisticated parts structure within the rear body. Its space-saving layout also enables a large-capacity storage compartment under the seat. Other characteristics include a sensitive touch screen, keyless control through smart phone connectivity, AI voice recognition, and so on, demonstrating the further development of the human machine interface (HMI) as an electronic brain. Combined with a medium- to long-term maintenance plan and charging infrastructure within India, its smart and clean styling present a new benchmark for the next generation.

In 2022, several motorcycle manufacturers both inside and outside Japan announced future production and sales plans for electric models. As technological innovation



Fig. 19 Models Exhibited at EICMA (Kawasaki)



Fig. 20 LiveWire S2-Del Mar



Fig. 21 Ola Electric S1

continues to accelerate, there are increasing expectations for the creation of outside-the-box designs and values that emphasize customer experience.

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