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DIGITAL POLICING PORTFOLIO

Frontline Digital Mobility National Guidelines

Portable Power Banks

February 2020

FRONTLINE DIGITAL MOBILITY

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1. Context

Mobile devices such as smartphones, laptops, tablets/phablets, as well as body worn video, are widely used by frontline officers and staff across police forces nationally. With shifts of 12 hours or more, there is a need for these often mission critical devices to remain charged. The move towards greater mobile working is likely to increase this need, as officers and staff become more reliant on their mobile devices.

While newer devices have much improved battery lives, for those forces who have some older devices in their technology estate, or who have roles that demand lots of use from their devices, remote battery charging away from mains electricity is required.

While there are a number of ways in which device battery power can be conserved, forces consulted suggest that these are not always suitable for police use. For example, there have been reports that having devices on low power mode terminated their VPN connection and that app optimisation can affect app performance. A portable power bank therefore provides a practical solution to ensure that device batteries remain charged.

This guideline has taken the view that portable power banks should be capable of charging a device with a flat battery (in the unfortunate event a shift commences with a flat battery), but that power banks will most often be used to "top up" an already mains electricity charged device's battery during the course of a shift.

In-vehicle device chargers have an important role to play, especially for larger, more power hungry devices such as laptops. Personal issue portable power banks are better suited to smaller devices, like smartphones, especially for frontline officers and staff who patrol on foot/bicycle or who are typically away from a vehicle. This could become a more frequent requirement with a continued focus to see frontline officers and staff both on our streets and visible to the public.

Portable power banks are a tried and tested peripheral. Advances continue to be made to make them faster, better and smaller. Yet there are many types of power banks available in the market place with many variances in terms of specification, features and of course price. This guideline explores these variances and makes recommendations (see section *4. Recommendations,* page 3) to help forces make informed selections so as to accelerate their mobility maturity.

2. An Introduction to the technology

2.1 Portable power banks

A portable power bank (hereafter power bank) is a peripheral used to provide remote charging to rechargeable battery powered portable devices. Power banks are comprised of a battery, a case and a circuit to control power flow in and out. They store electrical energy which can be reused to charge smartphones, tablets/phablets, body worn video and other portable devices which require regular remote recharging. Typically any device which can be charged by USB from a mains power supply can be charged from a power bank, (as long as the power bank itself has charge).

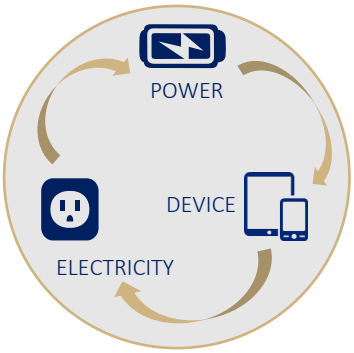


Figure 1

Batteries in laptops are larger than those in smaller devices, such as smartphones, and therefore they require power banks with a significantly higher capacity, which are generally heavy and bulky to carry and more expensive. As a consequence, while laptop charging will be mentioned in this guideline, it is recommended that portable laptop power banks are not used with laptops.

3. Benefits

Power banks offer a range of benefits for frontline mobility enablement. These are detailed below.

BENEFIT 01
LOW COST
A low price point peripheral to purchase.

BENEFIT 02
PORTABLE
A portable peripheral that can be used outside of police stations, further enabling frontline mobility.

BENEFIT 03
SUPPLIER AGNOSTIC
Portable power banks are able to charge a range of devices, such as smartphones, tablets, and body warn video.

BENEFIT 04
BACK UP
Can help ensure officer and staff's mission critical devices remain charged - improving safety and their ability to execute their duties.

BENEFIT 05
MULTIPLE DEVICES
Able to charge multiple devices simultaneously.

BENEFIT 06
FAST CHARGING
Offers fast charging capabilities.

BENEFIT 07
HOLDS NO DATA
Stores no data and does not require a connection type which could be compromised.

BENEFIT 08
LOW MAINTENANCE
Requires little to no maintenance.

Figure 2

4. Recommendations

A defined list of guidelines have been established and detailed below.

Guideline ID	Recommendations	Section Ref	Guideline Theme
GL-PPB-01	Batteries in laptops are larger than those in smaller devices, such as smartphones and tablets, and therefore they require power banks with a significantly higher capacity, which are generally heavy and bulky to carry and more expensive. As a consequence, while laptop charging will be mentioned in this guideline, it is recommended that portable laptop power banks are not used with laptops.	2.1 Portable power banks	Availability
GL-PPB-02	Forces should give careful consideration to the most optimal port/cable arrangement for their force. Fewer fixed cables are considered better to prevent loss and simplify charging both the power bank and the device.	6.4.1 Port types and cables	Compatibility
GL-PPB-03	If frontline officers and staff are carrying multiple devices then a power bank with more than one output port is recommended.	6.4 Input and output ports	
GL-PPB-04	A power bank in the price range of £30 to £45 is recommended. Due to the nature in which power banks would be used on the frontline and coupled with the fact many forces consulted do not replace damaged power banks, devices above this price range are considered unlikely to deliver best value for money.	6.9 Price	Cost
GL-PPB-05	Forces are recommended to explore bulk purchasing power banks, which could reduce down the price per unit cost.	6.9 Price	
GL-PPB-06	A Lithium-Polymer battery power bank is recommended. This is because they are more robust, less prone to leakage and have a longer lifespan compared to a Lithium-Ion battery.	6.3 Battery types	Durability
GL-PPB-07	It is recommended that a power bank has a capacity higher than the device(s) requiring to be charged. A power bank with a capacity of at least 10,000 mAh is specifically recommended to ensure it is capable of charging tablets as well as smartphones. A 10,000mAh power bank is typically capable of charging a smartphone three times, or a tablet 1.5 times.	6.2 Capacity	Performance
GL-PPB-08	Given the time pressured environment of frontline policing, to allow faster charging time, higher output current fast charging power banks are recommended.	6.4.2 Output charge and fast charging	

GL-PPB-09	While forces could benefit from having ruggedised and IP rated power banks, they do tend to be heavier and more expensive. Given that forces report that when selecting cheaper peripherals they are less concerned about damage it is recommended that that additional expense and weight is spared and non-ruggedised/IP rated power banks are selected.	6.7 Ruggedisation and environmental proofing	**Ruggedisation and environmental proofing**
GL-PPB-10	It is recommended that certified power banks are selected that have been tested by a certified laboratory to meet specific standards and feature one of the below logos:  It is further recommended that power banks are selected with in-built safety features such as OVP, OTP and OCP	6.8 Other features	**Safety/ Security**
GL-PPB-11	High quality cables are recommended, since they offer more protection from possible power surges and overheating, which can damage connected devices.	6.4.1 Port types and cables	
GL-PPB-12	To ensure the power bank does not add additional burdensome weight to what officers and staff already need to "personal carry" it is recommended that a power bank weighs no more than 250 grams. It is also recommended that to ensure the power bank can fit comfortably into uniform pockets that it is no larger than 15cm x 10cm x 2cm.	6.6 Size and weight	**Usability**
GL-PPB-13	Power banks with a digital indicator display are recommended since they give a precise read-out of the charge remaining.	6.5 Power remaining indicators	
GL-PPB-14	Universal power banks have the benefit of allowing a user to use the device whilst it is charging. They also offer the fastest device charging speeds as they release the strongest charging current. This guideline recommends the use of universal type power banks for frontline mobility enablement.	6.1 Power bank types	

Table 1

5. Market place

5.1 Technology maturity

Portable power banks are in use across police forces nationally. They are a tried and tested technology that have advanced considerably since their introduction in 2001. Today there is a competitive power bank market with many different suppliers and specifications and features available.

6. Technology specification and features

6.1 Power bank types

There are three main types of power banks; *Universal, Wireless and Solar.*

- *Universal*
  Universal power banks are most common, since they are compatible with more devices compared to wireless and solar power banks. Their internal battery is charged from a USB source connected to a mains electricity supply. They then charge the battery of a connected device through a cable. Universal power banks have varying input and output port types. Universal power banks have the benefit of allowing a user to use the device whilst it is charging. They also offer the fastest device charging speeds as they release the strongest charging current.

- *Wireless*
  Wireless power banks tend to be more expensive. Like universal power banks, they are charged from a USB source connected to a mains electricity supply. However, they have the benefit of being able to transmit power directly to a device without a connecting cable. A device is instead placed directly on top of the wireless power bank to enable the power transfer. The power is created from an electrical current passing through two coils, creating an electromagnetic field. This field charges the connected device's internal battery. Wireless power banks can only wirelessly charge devices compatible with wireless charging. In addition they provide a lower charge current, resulting in longer time to charge the device than it would take with a cable.

- *Solar*
  Solar power banks have photovoltaic panels on their external case which harness sunlight to charge their internal battery. They then charge the battery of a connected device through a cable. The solar cells are small and therefore the internal battery takes a long time to charge (relative to universal and wireless power banks). As a consequence these power banks have been discounted from this guideline as they have been deemed not suitable for policing requirements.

Universal power banks have the benefit of allowing a user to use the device whilst it is charging. They also offer the fastest device charging speeds as they release the strongest charging current. This guideline recommends the use of universal type power banks for frontline mobility enablement.

6.2 Capacity

One of the biggest considerations when selecting a power bank is the capacity of it. Capacity is measured in mAh (milliamp hours) which denotes the capacity for power flow over time. Common sizes range from 1,000 to 30,000 mAh – the bigger the mAh the more power and more times you can recharge a device. They are usually sold in 5,000, 10,000 and 20,000 mAh capacities.

The 5,000 mAh capacities are usually single-use power banks, the 10,000 mAh capacities offer a minimum of two charges and the 20,000mAh capacities (and above) are the most useful for regular use when there is no access to main power for an extended period of time and/or charging multiple devices at the same time.

To complete one full charge of a device, the power bank must have a slightly higher capacity than the device it is charging. This is because a power bank does not run at 100% efficiency, as when power is transferred it is dissipated as heat (due to the inherent resistance in cables and components).

It is recommended that a power bank has a capacity higher than the device(s) requiring to be charged. A power bank with a capacity of at least 10,000 mAh is specifically recommended to ensure it is capable of charging tablets as well as smartphones. A 10,000mAh power bank is typically capable of charging a smartphone three times, or a tablet 1.5 times.

6.3 Battery types

Power banks currently in production usually use one of two types of lithium batteries; Lithium-Ion or Lithium-Polymer. Both types have a long life expectancy and typically can carry out 500 charge/discharge cycles equating to, on average, a three-year lifespan. Over time, however, all lithium rechargeable batteries suffer from stress-induced ageing. This is because charging a battery forces ions from the cathode to the anode; using the battery reverses the flow. Eventually, this process wears out the cathode, which results in reduced capacity. Typically a battery will lose 20% or more of its capacity after 1,000 charge cycles.

Although Lithium-Ion and Lithium-Polymer battery types are similar in life expectancy they do have other different properties. These are detailed below.

- *Lithium-Ion*
  These battery types use electricity generating components, a positive electrode, a negative electrode and a liquid electrolyte between them. There is also an electronic controller which regulates the power flow so the battery does not overheat. These battery types are cheaper to manufacture, yet their higher power density creates difficulties with the ageing of the device resulting in them becoming harder to charge over time.

- *Lithium-Polymer*
  These battery types also use electricity generating components but the electrolyte between the positive electrode and the negative electrode is a dry solid instead of a liquid. This decreases the chance of the power bank leaking, enabling them to be more robust which increases their lifespan. They are, however, more costly to manufacture so may be less suitable if there is a high risk of the devices being misplaced or damaged.

A Lithium-Polymer battery power bank is recommended. This is because they are more robust, less prone to leakage and have a longer lifespan compared to a Lithium-Ion Battery.

A more detailed comparison of the difference between Lithium-Ion and Lithium-Polymer batteries is provided below.

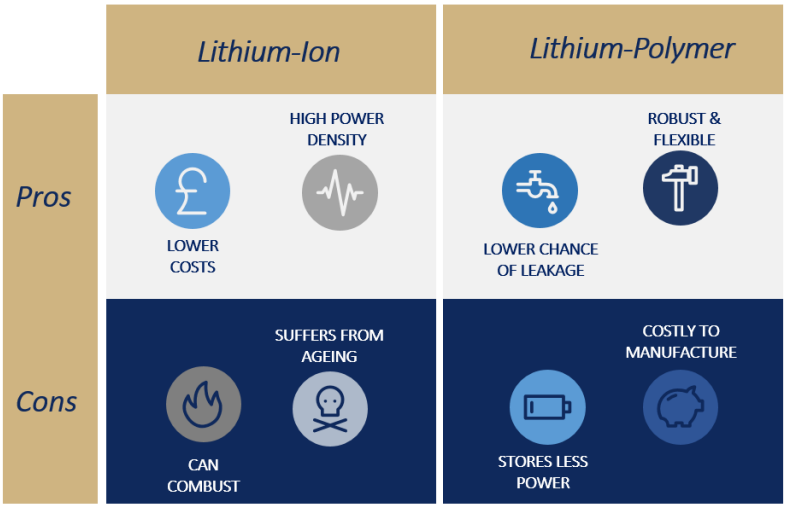


Figure 3

6.4 Input and output ports

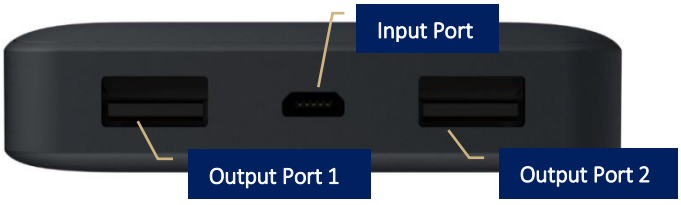


Figure 4 – An example of a power bank with two output ports capable of charging two devices simultaneously. For more detail about the port types see 4.4.1.

Universal type power banks have both input and output ports. The input ports are used to charge the power bank itself from the mains electricity supply and the output ports are used to charge the connected device(s). Multiple output ports enables simultaneous charging - with individual output ports capable of charging one device each. Cables are required to connect the ports between a mains power supply, a power bank and a device to enable charging (more detail at 4.4.1).

If frontline officers and staff are carrying multiple devices then a power bank with more than one output port is recommended. It is important to note that when charging multiple devices from a power bank simultaneously, the maximum current available to each port is likely to be reduced, therefore increasing the time taken to charge the devices (compared to only charging one device at a time).

Wireless power banks are able to charge devices without having output ports, yet many available on the market do have at least one output port. This enables them to charge a device using conventional cable charging in the instance that the device does not have the ability to be charged wirelessly.

If frontline officers and staff are carrying multiple devices then a power bank with more than one output port is recommended.

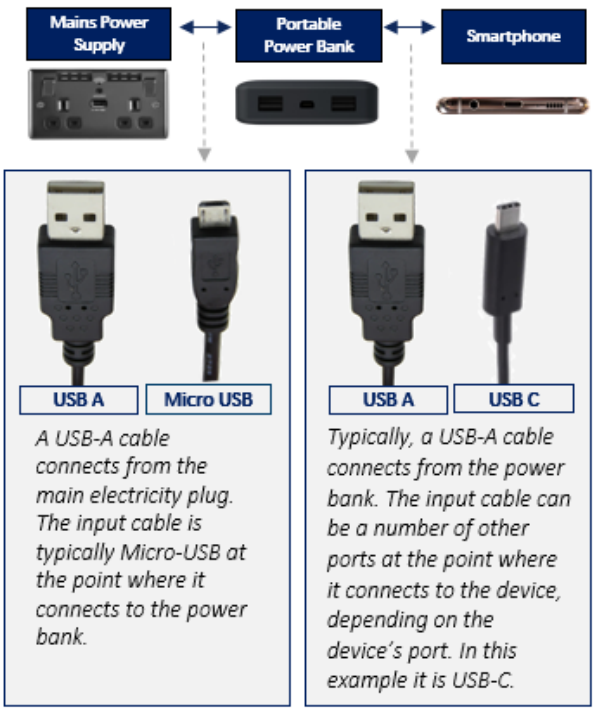
6.4.1 Port types and cables

USB (Universal Serial Bus) is the standard for connecting all sorts of devices today, but the "universal" in its name can be misleading, as there are many different tyes of USB connectors.

The most common USB is the USB-A. It's a rectangular connector that fits only one way. Micro USB , as the name suggests, is a tiny connector found on many popular kinds of portable devices. USB-C is the newest USB standard. Unlike the types above it is reversable. USB-C is being increasingly adopted by portable device manufacturers.

Cables connect the ports between a mains power supply and a power bank (the input cable), and the power bank and the device (the output cable). Some power banks come with detachable cables, while others have non-detachable cables preventing the loss of the cable but limiting the versatility of the product.

Figure 5



The output cable is typically USB-A (at the point where it connects to the power bank) and can be a number of other ports at the point where it connects to the device (depending on the device's port). For example the new generation Samsung smartphones use a USB-C port (therefore the cable would need to be USB-A to USB-C).

The input cable is typically Micro-USB (at the point where it connects to the power bank) and a USB-A (at the point where it connects into a mains electricity adaptor plug). However, the latest power bank models can be charged via USB-C port to USB-C port cables. This would be favourable to a force using USB-C port devices, since only one cable would be required to charge both the portable power bank and the device.

Forces should give careful consideration to the most optimal port/cable arrangement for their force. Fewer fixed cables are considered better to prevent loss and simplify charging both the power bank and the device.

High quality cables are recommended, since they offer more protection from possible power surges and overheating, which can damage connected devices.

6.4.2 Output charge currents and fast charging

Power banks have a specific current/rate at which they can deliver charge to a device. This is called the 'output charge current' and affects the time it takes a power bank to charge a device. If a device has multiple output ports then it is unable to deliver the maximum current from all of its ports simultaneously, taking a longer time to charge the device.

Charge power is a combination of voltage and amperage. An increase in voltage or amperage enables the power bank to drain more quickly and charge the connected device faster. Until more recently most power banks were only able to use 5V and a maximum current of 3A to produce a maximum power output of up to 15W.

Fast charging technology is becoming widely available. This enables device batteries to be charged faster than normal. Fast charging power banks are available, which when paired with compatible devices deliver more power therefore allowing the connected device to charge faster. USB Power Delivery (USB-PD) is the official fast charging specification. The standard can be used by any device with a USB port, provided its manufacturer includes the necessary circuitry and software. USB-PD implements a data protocol to communicate between the charger and device. This negotiates the maximum tolerable power delivery for both the charger and device. A device will only take the maximum current it can handle regardless of the maximum current a power bank can provide. USB-PD has increased the voltage to a maximum of 20V with a current of 5A creating a possible power level of up to 100W. It is important to understand, however, that fast charging does have a slight negative impact on device battery life, as a result of the additional heat generated. The effect of this however is considered to be modest.

Given the time pressured environment of frontline policing, to allow faster charging time, higher output current fast charging power banks are recommended.

6.5 Power remaining indicators

Power banks typically have one of two forms of indicators to display how much charge they have remaining. The most common form is the LED Indicator Display. All LEDs are lit when the power bank is fully charged and the number of LEDs lit diminishes as the charge depletes. LED Indicator Displays can be ambiguous to interpret, especially in the dark. Other power banks have a digital indicator display which gives a precise readout of the charge remaining.

Figure 6

Power banks with a digital indicator display are recommended since they give a precise readout of the charge remaining.

6.6 Size and weight

The size and weight of a power bank is an important consideration (if the intention is for personal issue) to ensure that officers and staff are comfortable with carrying the power bank in their uniform pocket. Portable power banks come in a range of different sizes and weights.

To ensure the power bank does not add additional burdensome weight to what officers and staff already need to "personal carry", it is recommended that a power bank weighs no more than 250 grams. It is also recommended that to ensure the power bank can fit comfortably into uniform pockets that it is no larger than 15cm x 10cm x 2cm.

6.7 Ruggedisation and environmental proofing

Rugged or "ruggedised" power banks are designed to be hard-wearing and protect against bangs and drops. They tend to have a thicker and stronger housing than non-ruggedised power banks, with the aim of withstanding shock and vibration. The highest achievable ruggedisation rating is MIL-STD-810G, which is a U.S. military specification that guarantees a level of durability meaning it should be field ready, or even "combat ready" in principle.

Power banks can also come with an environmental proofing rating known as an Ingress Protection (IP) rating. An IP rating is used to define levels of sealing effectiveness of electrical enclosures against intrusion from foreign bodies (dust etc.) and moisture. The numbers that follow the letters 'IP' each have a specific meaning: the first indicates the intrusion protection and the second defines the moisture protection.

The most common IP ratings are 65, 66, 67 and 68 and these are defined below:

- IP65 - rated as dust tight and protected against water projected from a nozzle.
- IP66 - rated as dust tight and protected against heavy seas or powerful jets of water.
- IP67 - rated as dust tight and protected against immersion for 30 minutes at depths 150mm - 1000mm.
- IP68 - rated as dust tight and protected against complete, continuous submersion in water (depth varies between manufacturers – generally three metres).

While forces could benefit from having ruggedised and IP rated power banks, they do tend to be heavier and more expensive. Given that forces report that when selecting cheaper peripherals they are less concerned about damage it is recommended that that additional expense and weight is spared and non-ruggedised /IP rated power banks are selected.

6.8 Other features

When a Lithium-Ion battery is being charged or is charging another device, it can overheat and cause a fire hazard. This is referred to as thermal runaway. Even when not in use or being charged, the battery's internal temperature may rise, yielding destructive and dangerous results. The fires that result from these batteries are difficult to extinguish. Safety standards have been developed to address hazard issues and to ensure the battery and power bank is safe both under normal use and foreseeable misuse. Standards and testing protocols provide manufacturers with guidance and direction for how to safely manufacture and use Lithium-Ion batteries. Certified products are those that have been tested by a certified laboratory to meet these specific standards.

Logos or marks, usually found on the packaging, will indicate that they have passed the necessary industry standard regulations. It is recommended that certified power banks are selected with one of the below logos.

Most new power banks also come with in-built safety features such as Over Voltage Protection (OVP), Over Temperature Protection (OTP) and Over Current Protection (OCP). These are detailed below:

- *Over Voltage Protection (OVP)*
  OVP is a power supply feature which shuts down the supply, or clamps the output, when the voltage exceeds a preset level, preventing damage to the electronic components.
- *Over Temperature Protection (OTP)*
  OTP is a power supply feature that shuts down the power supply when the internal temperature exceeds a safe value. A circuit is used to monitor and generate a trigger signal that starts the shutdown process at high temperatures.
- *Over Current Protection (OCP)*
  OCP is an electronic overload protection circuit. The power supply, as well as the connected loads, are electronically protected against overload by limiting the output current to a maximum value.

It is recommended that certified power banks are selected that have been tested by a certified laboratory to meet specific standards and feature one of the below logos:

It is further recommended that power banks are selected with in-built safety features such as OVP, OTP and OCP.

6.9 Price

Power banks vary in price depending on the specification and features of the peripheral. Prices are most likely to be affected by the following:

- A Lithium-Polymer battery type is more expensive than a Lithium-Ion battery type
- The greater the capacity of the power bank, the more expensive
- The more input and output ports a power bank has, the more expensive
- The greater the ruggedisation rating and IP rating, the more expensive
- Fast charging power banks are more expensive

A power bank in the price range of £30 to £45 is recommended. Due to the nature in which power banks would be used on the frontline and coupled with the fact many forces consulted do not repair damaged power banks, devices above this price range are considered unlikely to deliver best value for money. Forces are also recommended to explore bulk purchasing power banks, which could reduce down the price per unit cost.

7. How to get the best from the technology - Dos and Don'ts

Advice on how you should and should not use your power bank is detailed below.

Dos	Don'ts
✓ ***Do*** charge the power bank with a 2 amp or higher output charger. Lower output chargers will not charge the power bank as quickly. Use the power bank's original cable or a third party certified cable.	x ***Don't*** expose power banks to extreme temperatures as this could lead to damage of the lithium battery. Since vehicles can reach high temperatures in the summer and low temperatures in the winter it is important that power banks are not left inside them.
✓ ***Do*** take care when handling as dropping a power bank could lead to damage to the circuit board or lithium battery (unless the power bank is sufficiently ruggedised).	x ***Don't*** expose power banks to moisture as this could lead to damage (unless the power bank is water resistant).
✓ ***Do*** ensure the power bank is compatible with the device it is intended to charge.	x ***Don't*** store the power bank alongside metal objects in order to prevent the risk of short circuiting. Most new models come with in-built safety features including short circuit protection. However it is still advisable to keep the power bank away from objects such as coins, paper clips and keys.
	x ***Don't*** attempt to charge other devices at the same time as charging the power bank itself as this could lead to damage of the lithium battery (unless the power bank allows pass-through charging)
	x ***Don't*** leave the power bank on prolonged charge as this could lead to overheating. While most new models come with in-built safety features including over-temperature protection, it is still advisable to cease charging once full charge has been reached.

Table 2

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