Step-1

When the edge vectors a,b,c are perpendicular, the volume of the box is $\|a\|$ time $\|b\|$ times $\|c\|$.and

When $A=\left[\vec{a}\ \vec{b}\ \vec{c}\right]$ is 3 by 3 matrix.

Step-2

With mutually perpendicular vectors $\vec{a},\vec{b},\vec{c}$ we have

$$A^T A=\begin{bmatrix}\vec{a}\\ \vec{b}\\ \vec{c}\end{bmatrix}\left[\vec{a}\ \vec{b}\ \vec{c}\right]$$

$$=\begin{bmatrix}\vec{a}.\vec{a} & \vec{a}.\vec{b} & \vec{a}.\vec{c}\\ \vec{b}.\vec{a} & \vec{b}.\vec{b} & \vec{b}.\vec{c}\\ \vec{c}.\vec{a} & \vec{c}.\vec{b} & \vec{c}.\vec{c}\end{bmatrix}$$

$$=\begin{bmatrix}\|a\|^2 & 0 & 0\\ 0 & \|b\|^2 & 0\\ 0 & 0 & \|c\|^2\end{bmatrix}$$

Step-3

And hence

$$\begin{aligned}\det\left(A^T A\right)&=\det A^T.\det A\\ &=\det A.\det A\\ \det\left(A^T A\right)&=\left(\det A\right)^2\end{aligned}$$

Step-4

$$\det\left(A^T A\right)=\|a\|^2\|b\|^2\|c\|^2$$

$$\Rightarrow \det A=\|a\|\|b\|\|c\|$$

Thus,

$$\boxed{\det A^T A = \|a\|^2 \|b\|^2 \|c\|^2}$$

$$\boxed{\det A = \|a\|\|b\|\|c\|}$$