Continuum robots offer superior dexterity, compliance, and adaptability compared to traditional rigid-link manipulators, making them highly suitable for operations in constrained or unstructured environments. This paper presents the design, fabrication, modelling, and experimental validation of a two-segment hybrid continuum robot actuated by pneumatic artificial muscles (PAMs) and tendons. The first segment is powered by six PAMs arranged symmetrically around a central backbone, while the second segment is controlled by six tendons driven by stepper motors. A pressure regulation system enables precise control of the PAM contraction, and a tendon-tension control mechanism ensures accurate bending of the distal section. The kinematic model was derived based on constant-curvature assumptions for both segments and extended to include hybrid actuation coupling. A dual-camera vision system was employed to measure the robot's 3D motion in the XZ and YZ planes, and a BNO055 inertial measurement unit was used to capture orientation angles (α, β, γ) in real time. Experimental tests were conducted for muscle-only, tendon-only, and hybrid actuation cases. Results show close agreement between theoretical predictions obtained from the kinematic model and actuator–curvature mapping and experimental measurements, with an overall deviation of less than 10% across all configurations. The proposed hybrid actuation design demonstrates improved spatial accuracy, repeatability, controllability, and increased payload capacity compared to single-mode actuation, confirming its potential for soft manipulation tasks and minimally invasive robotic systems.