Nano-sized spinel ferrites have attracted heightened scientific focus due to their interesting structural, morphological, magnetic, optical, and electrical properties. Metal substitution in the structural equation of the spinel ferrite (MFe_2O_4) plays important roles in the modification of its physical properties in order to suits specific applications, like gas sensing. Recently, air pollution has greatly increased, e.g., leakage of liquid petroleum gas (LPG). This lead to deaths, fire outbreaks and other health complication. As a result, there is demand for effective gas sensors with lower limits of detection. Sensing material especially the ferrites are limited in their sensitivity and operate at high temperatures. Among the ferrites, Mg-Zn ferrites are most important magnetic oxide due to their properties. Substitution of any magnetic ion by replacing Zn^{2+} in Mg-Zn ferrite plays an important role in modifying its properties and hence enhancing its sensing properties. This work, aimed at contributing to the effort focused to improve ferrite sensing properties and overcome these limitations by ternary ionic substitution. Consequently, $Ni_xZn_{0.5-x}Mg_{0.5}Fe_2O_4$ (x = 0, 0.1, 0.3 and 0.5) ferrite nanoparticles were synthesized by Citra gel auto-combustion method at a pH 7 and characterized for their structural, elemental composition, electronic and optical properties. Pre-elemental analysis by x-ray fluorescence revealed the expected stoichiometry of the synthesized nanoferrites with low amount of impurities. X-ray Diffraction analysis confirmed cubic spinel nature of the samples with crystalline size between 26.90-43.34 nm using Debye Scherrer equation, 8.94 – 26.38 nm using Modified Debye Scherrer plots and 11.60 – 23.86 nm using Halder Wagner plots. The most intense peak was at a miller indices (311), which is a characteristic of a spinel ferrites. Nickel substitution brought variation in the lattice constants which were in the range of 8.3436 – 8.4149 Å. Both Williamson – Hall and Halder-Wagner plots revealed all sample to possess compressive micro strain. Further structural properties by Fourier transform spectroscopy showed prominent peak at range of 350 – 450 cm^{-1} which are vibration of metal oxygen bond in octahedral sites while vibrations at 500 – 600 cm^{-1} which are vibration in tetrahedral sites, a characteristics of spinel ferrites with metal oxygen bond stretching. Optical properties by UV-Vis showed the samples optical band gap in the range of 4.19 – 4.21 eV, refractive index in the range of 2.048 – 2.562 and optical dielectric constant in the range 5.062 – 5.070. Kelvin probe scans revealed a low potential material and more interesting was the negative surface potential. The work function for the area scan was in the range 4.536 – 4.588 eV while for the line scan was in the range 4.341 – 4.5673 eV. Electrical conductivities of the samples were found to increase with increase in nickel content, this was determined from the calculation of length jump which was found to decrease from 2.975 Å to 2.942 Å. Similar results of variation of electrical conductivity were found by calculation of unshared edges which were found to decrease with nickel content from 6.9773 – 6.9181 Å. In summary, the synthesized nanoferrites have properties which could find their applications in fabrications of effective gas sensors, based on their size, band gap, length jump, and surface potential obtained.