I. INTRODUCTION

Infrastructures like roads, which form part of the foundation for economic and industrial development, are under intense stress both from environmental factors and heavy loads. These stresses cause deterioration in the structures over time. That being the cause is why the monitoring systems are needed to assure both safety and extend the lifespan [1].

With the increase in the number of heavy vehicles, the problems with transportation infrastructure have been getting serious all around the world[2]. The huge economic losses apart from damages, caused by excess loads give rise to questions on road safety[3]. In that respect, Load estimation systems play a vital part in road and bridge integrity preservation, reduction of the costs of repairs and weight regulation enforcement[4].

Overloading of vehicles raises serious concern about the safety of drivers, pavement durability, and road infrastructure as a whole, where the overweight of vehicles has been proven to contribute to traffic accidents, early roadway damage, and unfair competition between modes of transport and road transport companies[5]. In the order to overcome these problems, weigh stations are used in imposing weight restrictions where vehicles are weighed and fines are given for exceeding prescribe weight limits[6][7].

The Wireless Sensor Networks (WSNs) are the technologies in modern usage for many applications, such as smart cities, environmental monitoring, healthcare, and military surveillance[8][9]. The WSNs are spatially distributed sensor nodes that communicate with each other wirelessly, hence enabling them to gather, process, and finally transmit environmental data to a place usually called the base station[10][11].

Weigh-in-motion (WIM) systems are technologies that utilize a vehicle's weight while it crosses the road, which can dynamically be calculated[12]. The WIMs serve as a basis for weight enforcement, traffic control, and pavement condition assessment[5]. Application of the dynamic forces on the road surface by these WIM systems computes the weight against traditional weigh stations where the vehicles have to come to a complete stop in order for it to get statically measured.[13]. This reduces not only the latencies but also the throughput of collecting the data in a continuous stream[14].

Accelerometer-based WIM systems deviate widely from the status quo of how things are done by suggesting lightweight, low-cost, and readily deployable solutions[15][16]. These systems boast of being better since the accelerometers are able to measure vertical vibrations caused by moving vehicles which can be processed to give estimates of axle and gross vehicle weights[17]. Their small infrastructure requirements make them ideal for deployment in resource-constrained environments, however, many existing systems rely on multi-sensor configurations limiting their applicability.[18].

Conventional WIM technologies are based on various in-pavement sensors, such as piezoelectric devices, strain gauges, bending plate, and fiber Bragg grating sensors, which measure the vehicle-induced stresses and vibrations. Such systems are often complex in sensor networks, hence more expensive and requiring bigger installation efforts[19]. Recently developed sensing and computing methods make possible the development of simpler and lower-cost solutions. It has the capacity to acquire abundant dynamic data and, in a way, combining the low cost, ease of installation, compact size, it makes the accelerometer-based WIM systems one of the promising alternatives[20].

Recent technological advances in sensors have also introduced accelerometer-based WIM systems, providing a lower-cost option[21]. They are small, inexpensive and easy to install but this acceleration-based WIM system has comparatively lower accuracy than the other alternative and more expensive options[22].

More advanced algorithms, therefore, can improve the estimation accuracy of load by adapting to various traffic conditions, vehicle types, and environmental conditions[23][24]. In developing more robust and adaptive monitoring systems, accelerometer-based approaches clearly are the way forward, as traditional ones face drawbacks such as sensitivity to temperature and repeated recalibration requirements[25].

This study investigates the possibility of using only one accelerometer sensor for load estimation in WIM systems, aim to discover less complex and more general available solutions.