ABSTRACT

This research is centred on designing a framework for application of systems engineering in non-conventional application areas. It uses the manufacturing – *small and medium enterprises* (SMEs) as a framing case. The *system engineering approach* (SEA) application and the value it brings is greatly appreciated in the traditional application areas like defence and aerospace industries, however, the SEA application in other industries particularly manufacturing has been very low. This has led to the mind-set that the formal systems engineering approach application is more practical and viable in high technology systems. The research focused on exposing the structural elements of the SEA combining the two systems engineering extremes (*soft* and *hard systems*) and proposing a framework tailored to the sophistication levels of the targeted manufacturing SMEs. The aim of the study was to illustrate that the SEA can be applied in other non-conventional applications areas.

The Delphi study was used as the front-end primary research instrument to get input to build the conceptual framework. This involved a pilot study and a two round Delphi iteration exercise. Sixteen (16) expert's participated in round 1 while twelve (12) participated in round 2. This represents a response rate of 20% in the first round and 80% in the second round. An acceptable convergence of opinion of over 67% was achieved on most of the proposed SEA process activities targeted for the manufacturing SMEs. The tools required to validate the conceptual framework and frame the final implementation framework were then extracted. The study then proposed a conceptual implementation framework targeting the low to medium technology manufacturing SMEs.

A *sustainable* hybrid SE framework is proposed in Chapter 7 which acknowledges the limitations and the constraints in the manufacturing SMEs in particular. This study adds to the body of knowledge of systems engineering by showing that a methodical approach can be followed in structuring a hybrid SEA for specific applications. The report concludes by recommending validating the proposed framework in pilot case study companies to provide useful comments and applicability levels within the targeted SMEs context.