ABSTRACT

Lean principles are now routines applied in manufacturing industries. Over a period of time some industries have adopted lean concepts not only for manufacturing but also for new product development process. If manufacturing results in creation of physical artifacts, new product design and development results in creation of information. It was found that industries are not able to derive real benefits of lean concepts as systems to assess leanness in new product development are seriously lacking. The present thesis bridges this gap by proposing a comprehensive leanness assessment system for new product development process. The framework developed and validated in this thesis has been demonstrated for design and development of machine tools. Both general purpose machine tools as well as special purpose machine tools pose challenges in terms of identification of wastes, identification of sources of wastes, identification of lean enablers and lean tools.

Lean implementation and assessment framework proposed in this research is termed as Lean Function Deployment (LFD). Three stage LFD framework consisting og three house of leanness is developed using lean performance measures (LPMs), wastes & waste drivers, lean enablers (LE) & lean tools (LT). In the first step, five lean performance measures, and wastes occurring in an NPD process are identified. LPMs and wastes as applicable to machine tool NPD process are specifically identified. Waste is any activity which has negative impact on lean performance measures, and sources of wastes known as waste drivers are also identified. Relation between wastes and LPMs is established as a part of first house of leanness.

In the second stage, lean enablers which can reduce, control or eliminate wastes have been identified and relation between the two is proposed. The relation between elan enablers and lean tools is developed as a part of third house of leanness. The three houses of leanness proposed in

this work corresponds to three aspects of lean implementation in new product development process namely: Identification, Adoption and Deployment. Each stage of LFD results in scores which can be used assess the leanness. The development of three stage process is based on inputs and validation from large number of industrial experts covering many industries. Finally the methodology proposed has been demonstrated by measuring leanness assessment indices in 27 machine tool industries.

As industries are fast adopting smart manufacturing and industry 4.0, leanness assessment in such environments calls for newer ways of measurement. In an environment of smart manufacturing, the product development and manufacturing process couplings are strong and integrated. To bridge this gap a new framework assessment of leanness for smart manufacturing systems is proposed. The methodology is based on identification of key parameters which define an SMS and mapping them to five lean concepts. The proposed methodology is again validated by taking inputs from 57 experts and covering several industrial case studies.

The leanness assessment frameworks proposed in the present thesis will empower industries in general, product designers and process planners in particular to assess the state of NPD process and to come with new products faster, cheaper, better and smarter.