Introduction
The importance of quality control in any manufacturing process has always been recognised. However, now more than ever before, it is a key requirement in order for manufacturing companies to remain competitive in this digital age. As a result of the complexities and globalization of the manufacturing supply chain, real-time product quality analysis based on advanced data based predictive models has become an important issue in the global manufacturing industry.

In metal hot forging processes in particular, the challenges associated with the need for more sophisticated process modelling and simulation tools, cost-effective self-tuning sensors and a lack of robust and efficient in-process monitoring technologies have limited the attainment of efficient real-time quality control of hot forged parts [1].

As such, there is a pressing need for research programmes aimed at providing effective in-process monitoring and quality control solutions to hot metal forging processes, by developing efficient real-time data-driven techniques for monitoring and improving the quality of hot forged parts. This will eventually help revolutionise the metal forging industry towards Industry 4.0.

Challenges
Some of the challenges in achieving this long-term ambition include:
- Difficulty in accessing product attributes during hot forging
- Absence of linear relationships between process and product parameters [2]
- Variation in input parameters in different hot forging operations
- High dimensionality of process data [3]

Research Questions
It is believed that answering the following research questions would be the appropriate starting point in tackling these challenges and meeting the research needs.
- What are the most significant process parameters in a hot forging process with regard to the desired product parameters? how are they determined and how can they be captured and analysed in real-time?
- What existing statistical and data analytical techniques are suitable for identifying the underlying relationships between forging process parameters and quality outcomes?
- Are these data analytical techniques best used alone or combined with traditional process monitoring and quality control techniques like SPC?
- What is the effectiveness of using data mining approaches in tackling the process monitoring and quality control problems in an industrial hot forging process?

Feasible Solutions
Recent research works have shown that the robustness of data mining techniques like artificial neural networks (ANN), decision trees (DT) and cluster analysis make them attractive for high complexity and high dimensional data.

Therefore, the proposed research investigates how unsupervised machine learning techniques like clustering techniques can be used to characterise the hidden relationships between process data and quality outcome of hot forged parts. The research approach would also analyse the classification and regression supervised-machine-learning techniques for identifying the optimal process parameters to monitor and for developing real-time part-quality predictive models.

Benefits
It is expected that such a solution would aid in identifying underlying the relationships between process parameters in a forging process that affects the certain predetermined quality characteristics of the forged part, as well as contribute to achieving the reduced reworks, fewer material wastes and fewer scraps in hot forging processes. A successful implementation of these techniques would also mitigate the costs associated with defective parts, lead to downtime reduction and improve the overall system performance.

References