Analysis of Uncertainty in the Development of Integrated Solutions

Executive Summary
The aim of this report is to provide insights into the uncertainty faced by manufacturers when developing integrated solutions. Integrated solutions are compound offerings comprising of a physical artefact (the product) and supporting engineering services. An example of integrated solutions is the Rolls Royce concept "Power by the Hour", charging the customer per hour of engine usage, not for the acquisition and maintenance of the engine itself. To provide these insights, this report describes the results of a benchmark study undertaken in the Nordic manufacturing industry. Six development cases of integrated solutions are compared and contrasted regarding the uncertainty encountered within five uncertainty types: Technical, environmental, resource, relational and organizational uncertainty. Moreover the six benchmark cases are analyzed regarding the criticality and latency of the uncertainty, as well as the uncertainty management practices applied. The benchmark study showed strong similarities as all uncertainty types were equally present:

- **Technical uncertainty** was encountered in modelling and forecasting of the machine performance, as well as the commercial scoping of the integrated solution.
- **Environmental uncertainty** was mostly characterized through uncertainty around country specific legal settings, challenges around the readiness of the customer for the offering, and the identification of the monetary value for the customer.
- **Resource uncertainty** centered strongly around human resources. Specifically the teams experienced uncertainty about the lack of project staffing, the availability of specialized skills (e.g. contracting, statistics), and the availability of staff to execute the integrated solution in the operational phase.
- **Relational uncertainty** emerged in the context of contracting through the identification of suitable terms and conditions for the integrated solution as well as the extent of risk included in the contract. Moreover, some companies engaged in co-creation processes and experienced relational uncertainty with the collaboration partners around hidden agendas, as well as quality and timing of the agree delivery.
- **Organizational uncertainty** emerged in the adaptation of the development process to the characteristics of the integrated solutions, the shift in culture towards appreciating the value of service, risk averseness of the organizations, the organizational change, and the impact of the integrated solution on the company’s business model. Successful management strategies for the uncertainty emerging during the development of integrated solutions comprised mainly of the application of agile management practices, a high focus on stakeholder management, the application of a pre-pilot before the actual development project, and a high percentage of employee staffing on the project (80% of their time or more). Moreover, the development of internal capabilities in the field of statistics, modelling and forecasting of machine performance and contracting have proven highly beneficial. Lastly, fast feedback iterations with the customer or even co-creation had strong impact on the project success through the assurance of the customer’s value. Concluding, all companies experienced all five uncertainty types. Depending on the type of offering developed they were present to a varying degree. Yet, the organizational uncertainty type was most present in each case.