UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Towards Cyber-Physical Product-Service Systems Design

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Doctor of Philosophy

under the supervision of Prof. Eng K. Chew, Dr. Phillippa K. Carnemolla, Prof. Shankar Sankaran and Dr. Man Hang Yip

University of Technology Sydney
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Certificate of Original Authorship

I, Mohd Ahsan Kabir Rizvi, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy in the School of Built Environment, Faculty of Design, Architecture and Building at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

I certify that the work in this thesis has not previously been submitted for a degree, nor has it been submitted as part of the requirements for a degree at any other academic institution except as fully acknowledged within the text.

This research is supported by the Australian Government Research Training Program.

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[1] Al Quran (96:5)
[2] Sunan Abu Dawud: 4811

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List of Abbreviations

ANT	Actor-Network Theory
BOL	Beginning of Life
CPPSS	Cyber-Physical Product-Service System
CPPSSDM	Cyber-Physical Product-Service System Design Method
CPS	Cyber-Physical System
DSRM	Design Science Research Method
EOL	End of Life
MOL	Middle of Life
PSS	Product-Service System
SDL	Service-Dominant Logic
SLR	Systematic Literature Review
VCC	Value Co-creation

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Abstract

As markets evolve, businesses recognise that customers perceive value in the utility of a product rather than in the product itself. Consequently, business strategies are being reconfigured from selling products to providing solutions. These solutions combine products and services to form systems which, with the advancement of technology, have developed into "smart" or "cyber-physical" product-service systems that provide numerous benefits to stakeholders through mutual collaboration. This research aimed to develop a service-oriented cyber-physical product-service system (CPPSS) design method that, through customer value co-creation, was adaptable to customers' dynamic needs.

The six-step design science research method used in this study helped to identify research opportunities and to develop and test the cyber-physical product-service system design method (CPPSSDM) reference model. Where earlier design methods have contributed to either actor-dynamics or service science, this study integrates the concepts of actor-network theory and service-dominant logic into a single methodological approach. This CPPSSDM consists of four stages which address how providers, managers, designers, and end-users (1) identify problems, (2) negotiate relationships, (3) integrate resources and (4) communicate solutions. At the same time, it contributes a new theory to PSS/CPPSS design literature with new research directions.

The case studies here and the practitioner feedback derived suggest that CPPSSDM facilitates continuous value co-creation for dynamic adaptation to customer needs. Further knowledge translation and improvement are suggested for the CPPSSDM through application in industry.

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