UTS UNIVERSITY OF TECHNOLOGY SYDNEY

SUPPORTING THE FORECASTING OF UNCERTAIN PRODUCT DEMAND IN SUPPLY CHAIN WITH DIGITAL TOOLS

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under the supervision of Professor Didar Zowghi, Dr Renu Agarwal and Dr Babak Abedin

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STATEMENT OF ORIGINAL AUTHORSHIP

I, Elias ABOU MAROUN declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Computer Science School / Faculty of Information Technology and Engineering 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.

This document has not been submitted for qualifications at any other academic institution.

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

Signature of Candidate

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Elias ABOU MAROUN

Dedication

This dissertation is dedicated in memory of my dear father Dib Tanios ABOU MAROUN and beloved maternal grandmother Nelly MAROUN, whom both entered eternal life during this research project.

To my dear father Dib, you played a significant role in my life, and I cannot thank you enough for the numerous sacrifices you made for the family. With your inspiration, love, and support, I have been able to meet challenges head-on. In your final moments, you were filled with words of encouragement and support, which I drew on to persevere with my studies and fulfil my ultimate goal. I promised to make you proud by continuing my studies to achieve this significant academic goal. I wish you were with me to share in the celebrations and success of my achievement.

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"One of the hardest lessons in life is letting go.

Whether it's guilt, anger, love, loss.

Change is never easy, you fight to hold on, and you fight to let go".

Khalil Gibran

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This thesis is only a beginning of my journey.

Elias Abou Maroun

"Progress lies not in enhancing what is, but in advancing toward what will be."

Khalil Gibran

List of papers/publications included

ABOU MAROUN, E., DANIEL, J., ZOWGHI, D. & TALAEI-KHOEI, A. 2018. Blockchain in Supply Chain Management: Australian Manufacturer Case Study, *Service Research and Innovation*, Australasian Symposium on Service Research and Innovation, Springer, Sydney, Australia, pp. 93-107.

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List of papers to be submitted for publication

ABOU MAROUN, E., ZOWGHI, D., AGARWAL, R. & ABEDIN, B. 2018. Exploring Uncertain Product Demand in Supply Chain: Systematic Review and a Theoretical Framework

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Abstract

This thesis examines the barriers faced in forecasting uncertain product demand within an electrical luminaire manufacturer in Australia. As luminaire technology has rapidly advanced in the last decade, the organisations' processes and systems for forecasting demand are no longer adequate. The accurate forecasting of uncertain product demand in the supply chain is understood to have financial consequences for organisations at all levels. Forecasting uncertain product demand is a fundamental part of the supply chain's sales and operations planning process. It lies at the strategic and tactical level within an organisation. The size and complexity of forecasting uncertain product demand are regarded as one of the more challenging activities in the supply chain. This is especially the case in the luminaire industry, where demand uncertainty, lack of historical data, and competitive environments coexist. Hence, judgemental adjustments are required to the forecast. The goal of adjusting the forecast is to optimise accuracy by allowing forecasters to contribute to the organisations' sales forecast. Our industry research's general premise is that the process of forecasting uncertain product demand in the supply chain could be improved in terms of transparency, efficiency, effectiveness, and useability by embedding a form of a digital toolkit. Many of the existing methods, tools, and approaches in forecasting uncertain product demand are either too complex for practice or cannot solve the barriers. In this research, we take a design science approach to investigate both state-of-the-art and state-of-the-practice to identify the barriers in forecasting uncertain product demand. We then develop and evaluate a software toolkit to support practitioners in forecasting uncertain product demand.

The first stage of the research is a systematic literature review involving a thorough review and critical analysis of existing theories on forecasting uncertain product demand. A pilot

study is then conducted to gain in-depth information about the overall supply chain domain and understanding who should formally be interviewed. The activities were informal and ad-hoc, it involved a walk around the office and asking informal questions to supply chain stakeholders, observing how people perform tasks and reading existing documentation. This is followed by a field study at the Australian Luminaire Manufacturer (ALM[1]), which consists of semi-structured interviews with end-to-end supply chain stakeholders and the elicitation of stakeholder requirements which we prioritise by using the card-sorting method. Based on the requirements prioritised, a toolkit is designed and developed to support the organisation in forecasting uncertain product demand. The designed and developed toolkit provides a set of tools, yet a cohesive set of software components that can be utilised to support the forecasting of uncertain product demand. The toolkit includes market segmentation and market intelligence reporting, a full forecasting model, and a framework to make forecast adjustments. The final stage of the research involved the evaluation of the toolkit. This involved a focus group and questionnaire with end-users. The research findings were also presented to the organisations executive management.

The empirical evaluations conducted showed that the toolkit improves the overall effectiveness of forecasting uncertain product demand. It was also revealed that the consideration of judgemental adjustments in the forecasting toolkit was both beneficial and practical for stakeholders.

This thesis offers interesting insights and valuable directions for managers contemplating investing in improving accuracy in forecasting uncertain product demand in the supply chain.

[1] Fictitious name used to maintain confidentiality

The research methods used and the successful application of the toolkit in the ALM were both novel and unique from previous work on forecasting uncertain product demand.