Development of a decision support model to capture and reuse the tacit knowledge in injection mould design for small and medium-scale enterprises

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DECLARATION

I declare that this is my own research, and this does not incorporate without acknowledgement any material previously published or submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Signature: Date: 04th February 2025

The above candidate has carried out research for the MPhil thesis under our supervision. We confirm that the declaration made above by the student is true and correct.

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Signature of the Supervisor: Date: *04th February 2025*

DEDICATION

Dedication to my beloved parents and teachers.

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ABSTRACT

Injection moulding is one of the most economical ways of manufacturing parts in large quantities. Here, achieving the expected quality of the finished products largely depends on the design and manufacture of the moulds. The design process of injection moulds is well established, but it is resource-intensive, requiring investment. Inability to invest in latest software tools and to employ experts are major concerns for small and medium-scale-enterprise (SME) mould manufacturers. Thus, they continue to rely on personal practical experience rather than modern and contemporary technology leading to a technological gap between the large- and small-scale mould manufacturing sectors. While explicit knowledge can easily be transferred from one generation to the other, there is no proven system in place to capture the tacit knowledge of employees, store it, and reuse it appropriately. Transferring the tacit knowledge to the successors has been difficult as understanding of the technology live within the individuals. Therefore, this research aims to identify the critical issues faced by the SME injection mould manufacturing sector and develop a decision-support model to capture and reuse the tacit knowledge within the organisations.

Initially current design practices, procedures, and problematic issues were identified through several rounds of surveys and interviews with experts (n=15) from the local industry. The study revealed that the local SME sector Injection Mould Design (IMD) industry is diminishing despite the increasing global demand. This study further identified several problematic areas, where retaining the knowledge of the experienced personnel at retirement is the major burning issue.

Several knowledge management (KM) models are in practice, yet they cannot be readily implemented as a solution to overcome the issues specific to the SME IMD industry. Therefore, a framework for capturing and reusing tacit knowledge was developed. In order to enable implementation of the framework, a decision-support model was also developed to support the decision-making process of IMD. Finally, the developed model was validated through case studies (n=4) in different industry settings. The decision support model to capture tacit knowledge can be used to design injection moulds with relatively simple components, mainly designed and manufactured by the SME sector mould makers. As future work, the functionality of the model can be improved by integrating artificial intelligence (AI) tools to introduce self-learning capability.

Keywords: Decision support, Expert modelling, Injection mould design, SME, Tacit knowledge management.

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Description** **Page**

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Description
ACM	Association for Computing Machinery
AI	Artificial Intelligence
ANN	Artificial Neural Network
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAM	Computer Aided Manufacturing
CN	Cavity Number
CNC	Computer Numerical Control
CNPF	Preferred Number of Cavities
D	Primary Runner Diameter
D_h	Hydraulic Diameter
DPG	Design Part Geometry
EDP	Explicit Design Data
GDP	Gross Domestic Product
HDPE	High Density Polyethylene
IEEE	Institute of Electrical and Electronic Engineers
IM	Injection Moulding
IMD	Injection Mould Design
KM	Knowledge Management
LSE	Large-Scale Enterprises
MDMA	Mould and Die Makers Association
NDP	Novice Design Data
NERDC	National Engineering Research and Development Centre
OPAC	Online Public Access Catalogue
PCN	Preferred Number of Cavities
PET	Polyethylene Terephthalate
PIMF	Part ID Matching Factor
RCPF	Runner Cross-section Priority Factor
RCPO	Runner Cross-section Priority Order
RD	Research and Development
RLPF	Runner Layout Priority Factor
RLPO	Runner Layout Priority Order
SF	Selection Factor
SFR	Selection Factor Rank
SFRE	Selection Factor Rank Explicit Data
SFRT	Selection Factor Rank Tacit Data
SME	Small and Medium-scale Enterprises
TDF	Tacit Data Factor
TDP	Tacit Design Data
TEPG	Tacit/Explicit Part Geometry

LIST OF APPENDICES