DEVELOPMENT AND EVALUATION OF IT SERVICE MANAGEMENT DIGITAL COMMONS – A CASE STUDY

A Thesis submitted by

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ABSTRACT

Information Technology Service Management (ITSM) is a set of organisational capabilities and practices for enabling value for customers in the form of services to plan, build and run IT functions. ITSM practice encompasses multiple process frameworks that are mutually aligned as well as complementary to each other. The availability of multiple frameworks could lead to the risk of implementing inefficient processes in organisations. On the other hand, the existence of multiple process frameworks can support process innovation if the ITSM practitioners can comprehend the ITSM knowledge ecosystem and the relationship between the different process frameworks holistically. In this research, a digital commons, that we refer as *Service-Symphony*, was built to support process innovation in ITSM practice. Digital Commons is a sub-set of knowledge commons that refers to creating and/or sharing data, information, knowledge, science, intellectual property, and other types of cultural and intellectual resources shared by many users. A Design Science Research (DSR) method was followed to develop Service-Symphony. This research contributes to the IS design theory through the development of digital commons design principle (DP)s that provide prescriptive guidelines to IS practitioners. Since the release of Service-Symphony in 2019, it is being used by practitioners and students from more than 22 countries across the globe with more than 122,360 user sessions. In 2019, Service-Symphony's relevance to practice was recognised by ITSMF Australia through the Business Innovation of the Year award.

Keywords: knowledge commons, IT Service Management, open-innovation, innovation-centric knowledge commons, digital commons, design science research

CERTIFICATION OF THESIS

I, Muralidharan Ramakrishnan, declare that the PhD Thesis entitled *Development and Evaluation of IT Service Management Digital Commons– A Case study* is not more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes.

This thesis is the work of Muralidharan Ramakrishnan except where otherwise acknowledged, with the majority of the contribution to the papers presented as a Thesis by Publication undertaken by the student. The work is original and has not previously been submitted for any other award, except where acknowledged.

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Student and supervisors' signatures of endorsement are held at the University.

STATEMENT OF CONTRIBUTION

Published Papers:

Paper 1:

Ramakrishnan, M, Shrestha, A, Cater-Steel, A & Soar, J 2018, 'IT service management knowledge ecosystem–literature review and a conceptual model', *Proceedings of the 29th Australasian Conference on Information Systems (ACIS 2018)*, Australian Association for Information Systems, https://doi.org/10.5130/acis2018.bu.

Student contributed 70% to this paper. Collectively Shrestha, A, Cater-Steel, A, & Soar, J, contributed the remainder

Paper 2:

Ramakrishnan, M, Shrestha, A & Soar, J 2021, 'Innovation centric knowledge commons—a systematic literature review and conceptual model', *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 7, no. 1, p. 35, https://doi.org/10.3390/joitmc7010035

Student contributed 80% to this paper. Collectively Shrestha, A,& Soar, J, contributed the remainder

Paper 3:

Ramakrishnan, M, Shrestha, A & Soar, J 2020, 'Inclusion of Complementary Industry Knowledge in IT Service Management Curriculum-A Case Study', *23rd Pacific Asia Conference on Information Systems (PACIS 2020),Dubai, United Arab Emirates*, p. 124, <https://aisel.aisnet.org/pacis2020/124>, https://aisel.aisnet.org/pacis2020/124.

Student contributed 80% to this paper. Collectively Shrestha, A, & Soar, J, contributed the remainder

Paper 4:

Ramakrishnan, M, Gregor, S, Shrestha, A & Soar, J 2022, 'Achieving Industry-aligned Education through Digital-Commons: A Case Study', *Journal of Computer Information Systems*, pp. 1-15, https://doi.org/10.1080/08874417.2022.2115955

Student contributed 80% to this paper. Collectively Gregor, S, Shrestha, A & Soar, J contributed the remainder

Submitted papers:

Paper 5:

Ramakrishnan, M, Gregor, S, Shrestha, A & Soar, J 2022, 'Development of design principles for platform enabled knowledge commons with an expository instantiation' submitted to *Journal of the Association for Information Systems* (JAIS) - status: Minor Revision

Student contributed 80% to this paper. Collectively Gregor, S, Shrestha, A & Soar, J contributed the remainder

Paper 6:

Ramakrishnan, M, Gregor, S, Shrestha, A & Soar, J 2022, 'The development and application of epistemic logic driven design principles for innovation-centric digital commons' submitted to *Decision Support Systems* Journal – status: Under Review

Student contributed 80% to this paper. Collectively Gregor, S, Shrestha, A & Soar, J contributed the remainder

ACKNOWLEDGEMENTS

My PhD journey started on a lazy afternoon when I was attending a workplace meeting. My mind wandered and the usual question came to me: "Can I do something more interesting?" Immediately after the meeting I sent an enquiry impulsively to Professor Aileen Cater-Steel whom I knew through my professional connections. To my surprise, within an hour I received a reply that she was happy to accept me as her student. Thanks, Aileen, for your encouragement and guidance during the initial stages of my research. Aileen introduced me to Dr Anup Shrestha as my associate supervisor and he has been a tremendous support throughout my PhD – challenging me to be creative, providing guidelines about academic expectations and serving as a sounding board on which to bounce ideas. Thanks, Anup, and I hope to continue the journey after PhD studies too.

Later that year, when I met Aileen at an industry conference, she told me that she would be retiring, and that Professor Jeffrey Soar would be my supervisor. Aileen assured me that I would enjoy collaborating with Professor Soar and, indeed, her prediction came true. I enjoyed collaborating with Professor Soar who ensured that my progress was on track by providing prompt feedback whenever his inputs were required. Thanks, Jeffrey!

It was a privilege to collaborate with Professor Shirley Gregor as part of my research. Professor Gregor is an acknowledged expert in design science research, and I am grateful that she kindly agreed to guide me as a co-author for my papers. Learning from Shirley was inspirational as her guidance would often be drawn from the arts and paintings, combined with her rich academic expertise.

One of the differentiating aspects of design science research is that the research outcome should be relevant to the practitioners. Right from its inception, the professional body, IT Service Management Forum (ITSMF), encouraged the research. Special thanks go to Bradley Brush and Brendon Cullen who have provided support. Thanks also to ITSMF for acknowledging this research through the Business Innovation Award in 2019.

The research artefact was guided by an expert panel. It was great to have the expert panel members, Harold Peterson, Dr Malcolm Blumberg, Brian Jennings, Stuart Harris and Candice Walker who evaluated the research artefact during the development.

My PhD journey would not have been possible without the support of my employer, Queensland Rail. I thank Tony Cook and Alison Day for consenting to support my research.

I would like to acknowledge the University of Southern Queensland (USQ) for providing an entrepreneurial grant to enhance the research artefact. This research has been supported by an Australian Government Research Training Program Scholarship. My sincere thanks to Trish Bartlett who has patiently proof-read the thesis.

And finally, thanks to my family members Sharada, Madhu, Anu, Appa and Amma who created a home environment conducive to the pursuit of my research.

DEDICATION

"If I have seen further, it is by standing on the shoulders of giants." – Sir Isaac Newton

To all researchers past, present and emerging who provide shoulders to other researchers to stand on to explore new areas

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

Abbreviation	Description
COBIT	Control Objectives for Information and Related Technologies
CQI	Continuous Quality Improvement
DP	Design Principle
DSR	Design Science Research
FEDS	Framework for Evaluation in Design Science Research
FG	Focus Group
IAD	Institutional Analysis and Development
ICT	Information and Communication Technology
IS	Information Systems
IGSM	IT Governance and Service Management
ITIL	Information Technology Infrastructure Library
ITSM	IT Service Management
ITSMF	IT Service Management Forum
IPDC	Industry Practice Digital Commons
IPR	Intellectual Property Rights
INDICO	INnovation-centric DIgital Commons
ISACA	Information Systems Audit and Control Association

KM	Knowledge Management
KMS	Knowledge Management Systems
KMC	Knowledge Management Capacity
MNC	Multi-national Corporations
MR	Meta-requirement
MOOC	Massive Open Online Courses
NPS	Net Promoter Score
PEKC	Platform Enabled Knowledge Commons
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
SLR	Systematic Literature Review

RESEARCH RECOGNITION AND COMMUNICATION

Service Management Innovation of the Year award: This national award was conferred to this research by ITSMF Australia for the contributions to the practitioner community through the ITSM knowledge commons – August 2019

USQ Ignition Entrepreneur grant – This grant was awarded to this research to further the development of ITSM knowledge commons for the benefit of the student community by the University of Southern Queensland – January 2020

USQ Dean's Award for Outstanding Research Presentation – second place for the paper 'The development of epistemic logic driven design principles for innovation-centric knowledge commons' - awarded by the University of Southern Queensland – September 2021

Participation in MISQ virtual author development workshop and presented the paper 'An exemplar mid-range theory development and application' - August 2020

Presentation at University of Cologne (virtual) on the topic 'Platform Enabled Knowledge Commons – An exemplar mid-range theory development and application' - November 2020

CHAPTER 1 INTRODUCTION

Information Technology Service Management (ITSM) is an industry practice that enables IT services to be customer-centric and aligned with business needs (Berger, Shashidhar & Varol 2020). ITSM encompasses many practice areas including strategy, design, transition, operations, and continual service improvement (Marrone et al. 2014; Veronica & Suryawan 2017) and includes complementary practices such as governance, project management, enterprise architecture and continual improvement. The frameworks covered in the ITSM knowledge commons include ITIL, ISO/IEC 20000, COBIT, ITIL, PMBOK, Agile, Lean Six Sigma, and DevOps (Pardo et al. 2013; Ramakrishnan et al. 2018; Ramakrishnan, Shrestha & Soar 2020). An organisation often needs to leverage more than one process framework to meet its needs (Cater-Steel, Tan & Toleman 2006; Heston & Phifer 2011). On the other hand, presence of multiple process frameworks often confuses the practitioners, thus leading to inefficient processes in the organisation (Heston & Phifer 2011; Pardo et al. 2013).

This research hypothesised that a purpose-built digital commons that is referred to as Service-Symphony (Ramakrishnan 2019) will help ITSM practitioners to navigate through a myriad of process frameworks, understand the relationships between them and provide a holistic view of the ITSM practice. As comprehending knowledge is a precursor to innovation (Allen & Potts 2016), it is claimed that Service-Symphony contributes towards process innovation.

Digital commons is a sub-set of Knowledge Commons. Knowledge commons is a term used to describe the institutional arrangements of creating and managing knowledge as a shareable resource (Frischmann, Madison & Strandburg 2014). Knowledge commons theory is an extension of the commons theory which is a prominent economic theory that analyses the sustainability of the sharing of natural resources such as

rivers, forests and fisheries (Ostrom 1990). Knowledge commons plays a significant role in creating and disseminating knowledge at an individual level, within organizations, among communities and across nations.

Digital commons refers to creating and/or sharing data, information, knowledge, science, intellectual property, and other types of cultural and intellectual resources shared by many users. In digital commons, knowledge sharing is facilitated by a digital platform. Digital libraries, medical research commons, Wikipedia and organisational digital repositories are some examples of digital commons. In this research, digital commons is also referred to as platform-enabled knowledge commons (PEKC). These terms are used interchangeably in the rest of thesis.

Digital commons contributes to the addressing of a diverse range of problems including disease genomic data (Piñero et al. 2020), domestic violence prevention (Rodríguez-Rodríguez et al. 2019), and technology sharing (Schneider, Huth & Vietor 2021). During the COVID pandemic, digital commons played a vital role in disseminating crucial information like ventilator design and other scientific knowledge (Brasseux & Ngo 2020; Tavernier 2020).

For designing and evaluating Service-Symphony, this research adopted the Design Science Research (DSR) paradigm (Von Alan et al. 2004; Peffers et al. 2007). DSR addresses three core aspects of building the IS artefact: relevance, rigour and design (Hevner 2007). The Relevance Cycle connects the target user environment with the design of the artefact. The Rigor Cycle establishes and/or leverages theories and methods. The design of the artefact bridges the relevance and rigour cycles through multiple iterations. This research contributes to the DSR knowledge by deriving and applying IS-specific design principles (DPs) that capture the 'know-how' aspect of building the IS artefact (Gregor & Hevner 2013a; Gregor, Chandra Kruse & Seidel 2020). The DPs are

considered a key part of design theory (Gregor & Jones 2007; Gregor, Müller & Seidel 2013; Baskerville et al. 2018; Gregor, Chandra Kruse & Seidel 2020). This research demonstrated the development of digital commons DPs from multiple perspectives by formulating the DPs from knowledge governance and epistemic dimensions perspectives.

The knowledge governance DPs were already codified by analysing the successful commons practices as part of commons theory (Ostrom 1990; Hess & Ostrom 2007). Ostrom's DPs served as a starting point for developing digital commons DPs from a knowledge governance perspective. Though it served as starting point, the DPs had to be analysed critically and tailored to be relevant to IS practice. This research developed 10 digital commons DPs by:

- analysing systematically the characteristics of knowledge to propose additional design principles that are not covered in Ostrom's natural commons design principles;
- examining the existing natural commons DPs concepts and terminology and tailoring the principles to suit IS practitioners;
- applying the proposed expanded set of digital commons DPs in constructing Service-Symphony; and
- evaluating the DPs from the perspective of IS Architects who form one of the target audiences of the DPs.

The second set of DPs was developed from the epistemic dimension's perspective. Epistemology, the study of knowledge, has a long tradition in philosophy, starting with the early Greek philosophers and applied in diverse fields including economics, computer science and Artificial Intelligence (Fagin et al. 2004; Meyer & Van Der Hoek 2004). Epistemic logic is a study of systemic properties of knowledge (Hendricks 2015). This research developed a conceptual model for Innovation-Centric Digital Commons – INDICO, based on the three dimensions of epistemic logic comprising self-knowledge, common knowledge, and distributed knowledge. The DPs derived based on these dimensions were applied to

Service-Symphony and shown how the design features aligned with the DPs.

Connectivism learning theory (Siemens 2004; Goldie 2016; Downes 2019; Utecht & Keller 2019) was another theoretical framework used in this research while applying the ITSM digital commons as a complementary learning resource for students enrolled in ITSM courses at the University of Southern Queensland (USQ). Connectivism learning theory is characterised as social learning through knowledge networks underpinned by technology (Downes 2019), including specifically in digital learning contexts. This research applied the eight principles of connectivism learning theory to ITSM digital commons.

The research context is shown in Table 1-1.

TABLE 1-1 RESEARCH CONTEXT

Research paradigm	Design Science Research		
Nascent theories	Commons theory	Epistemic logic	Connectivism theory
Problem domain	IT Governance and Service Management		
Deliverables/ Contributions	**Theory** Development of DPs from knowledge governance perspective Development of DPs from epistemic dimensions perspective Development of conceptual model for ITSM digital commons Application of Institutional Analysis Development (IAD) framework for Open Innovation		**Practice** Development of ITSM digital commons Reusability evaluation of Design Principles by practitioners Evaluation of ITSM digital commons by students and practitioners

	Development of conceptual model for Innovation-centric digital commons based on epistemic dimensions Development of Conceptual model based on Connectivism theory	
Target Communities	IS Architects	ITSM Practitioners ITSM Students IS Educators

1.1 PROBLEM STATEMENT

The motivation for developing a purpose-built knowledge platform initially came through my observations and reflections as an ITSM practitioner. I observed that each practice area was operating in silos without collaboration between other practice areas. As a result, the organisations were not operating efficiently and effectively. To validate the initial observation, a systematic literature survey (SLR) was conducted to understand the ITSM research landscape. The SLR identified 41 research papers that discussed multi-process harmonisation and highlighted that the research was primarily focussed on consolidating only a handful of frameworks as opposed to providing a holistic view of the service management practice (Ramakrishnan et al. 2018). The ontology-based integration and mapping (Pardo et al. 2012a; Valiente, Garcia-Barriocanal & Sicilia 2012; Pardo et al. 2014) is not suitable for comprehending a large number of process frameworks due to its inability to manage large amounts of information (Mejia, Muñoz & Muñoz 2016).

Among the 41 papers studied in the SLR, 38 focussed on process frameworks and three on skills areas. It was observed that, while the extant research is focussed on process frameworks, it did not provide a

holistic view of the ITSM knowledge eco-system, and the artefacts proposed in the research were not designed to be continually evolving.

The SLR and industry feedback suggested the need to develop ITSM digital commons. The problem statement can be summarised as:

> *Within the ITSM Knowledge ecosystem, no single platform exists that provides a holistic, current view of knowledge.*

The problem statement captures a key gap in the ITSM ecosystem. For example, consider a scenario where a practitioner wants to understand how Change Management is addressed in ITSM frameworks such as ITIL v3, ITIL 4 and COBIT. Without the existence of a single knowledge platform, the practitioner must browse through different document libraries and compare them to get an understanding. More importantly, if there are other frameworks that address Change Management, the single holistic platform would bring it to the attention of the practitioner. Since the practitioner may not be aware of the new framework, they would miss out researching about it, in the absence of a single, holistic platform.

1.2 NEED FOR ITSM DIGITAL COMMONS

ITSM has been researched by academics since 2005 (Hochstein, Tamm & Brenner 2005) as noted by (Iden & Eikebrokk 2013) The early researchers focused on ITIL which is considered a de facto standard for ITSM (Cater-Steel, Toleman & Tan 2006; Latif, Din & Ismail 2010; Jarman 2011; Marrone et al. 2014)

ITIL version 1 was developed during the 1980s by the Central Computer and Telecommunications Agency (CCTA), a British Government agency, and widely adapted by the industry after the ITIL version 2 was released between 2000 and 2002. (Iden & Eikebrokk 2016). Since then, ITIL has been updated with releases in-line with changing industry and technology needs. The latest release, ITIL4, was released in 2019 (Axelos 2019; Berger, Shashidhar & Varol 2020)

There are other aligned and complementary frameworks that support ITSM practice. COBIT focusses on the governance aspect of ITSM (Stroud 2010; Parvizi, Oghbaei & Khayami 2013; Sánchez Peña, Fernández Vicente & Ocaña 2013; Veronica & Suryawan 2017; Steuperaert 2019) and ISO/IEC 20000 provides a quality management framework that enables the organisations to be audited (Van Bon & van Selm 2008; Cater-Steel, Hine & Grant 2010).

When a broader interpretation of ITSM is considered, as opposed to operations, the scope of the practices covered expands accordingly. The practices covering strategy, knowledge management, enterprise architecture, continual improvement, portfolio management, program, and project management, DevOps and customer relationship management become part of the broad ITSM.

ITSM is expanding as an enterprise practice as opposed to limiting the scope only to IT. The Enterprise Service Management (ESM) encompasses human resources (HR), Legal, property development and field service management (FSM) besides IT (Maes 2022).

The broad interpretation of ITSM and the ESM trend implies that the ITSM practitioners need to consider multiple processes to design an end-to-end optimum process framework in their organisation.

1.2.1 INTRA-ORGANISATION APPROACH TO PROCESS INTEGRATION

The challenge of multi-process complexity for IT practitioners is a known issue in the IS practice community and has also been acknowledged by IS researchers (Heston & Phifer 2011; Pardo et al. 2012a; Pardo et al. 2013; Pardo-Calvache et al. 2014).

The empirical study conducted by Cater-Steel, Tan and Toleman (2006) concluded that many organisations need to leverage multiple ITSM process reference frameworks. The study cites complementary objectives such as legal compliance, risk management, cost-effectiveness, and

customer satisfaction as the reasons for adopting these multiple frameworks. There are many frameworks in ITSM such as ITIL, COBIT, ISO/IEC 20000 and complementary practices like DevOps, Lean Six Sigma, Enterprise Architecture and Project Management. Each framework in turn consists of multiple processes and practices such as change management, incident management, problem management and service level management. The practices amongst frameworks are broadly aligned but the terminology and the approach can differ. Each framework has its strengths and limitations, as shown by Heston and Phifer (2011). The adoption of multiple frameworks brings additional benefits to organisations by exploiting their synergies (Jeners, Lichter & Rosenkranz 2013). On the other hand, the selection of relevant frameworks is complex and challenging without the right knowledge (Heston & Phifer 2011; Valiente, Garcia-Barriocanal & Sicilia 2012; Pardo et al. 2013; Mejia, Muñoz & Muñoz 2016).

The extant research has focussed on one of two approaches to choosing process frameworks: (a) *mapping* of similar process reference models; and (b) *integration/harmonisation* of frameworks based on a formal ontology. The *mapping* solution involves documenting the relationships and commonalities of processes across similar frameworks (Ehsan et al. 2010; Karkoskova & Feuerlicht 2015; Ekanata & Girsang 2017). The ontology-based *integration* solution formalises the mapping by developing an ontology and building a unified model (Pardo et al. 2012a; Pardo et al. 2013; Pardo et al. 2014).

1.2.2 EXO-ORGANISATION APPROACH TO PROCESS IMPROVEMENT

Both integration and mapping solution approaches assume implicitly that the organisations know the frameworks that are relevant to their businesses. In a dynamic ecosystem, the organisations may not be aware of the existence of emerging frameworks (Pricope & Lichter 2011). In addition, Mejia, Muñoz and Muñoz (2016) point out that one of the

challenges of multi-model integration is managing a large amount of information and decision-making thereby limiting scalability. Further, the models are not designed inherently to evolve together with changes in the environment as each model evolves independently without consideration of other models

Figure 1-1 summarises how this research fits within the research landscape. This research focusses on knowledge outside the boundaries of the organisation and considers that a holistic view of process frameworks is a precursor to the kindling of process improvement and innovation within the organisations.

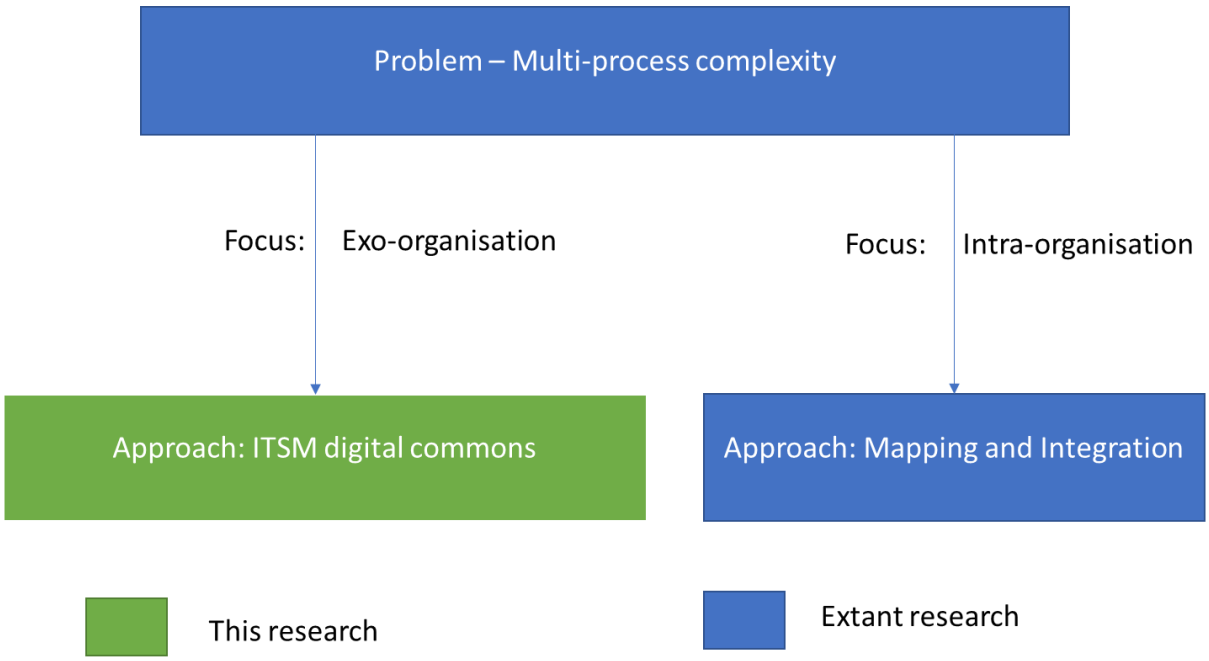

FIGURE 1-1 POSITIONING OF THIS RESEARCH WITHIN THE ITSM RESEARCH LANDSCAPE

1.3 AIMS AND OBJECTIVES

The scope of this thesis is to address two objectives and the associated research questions. The first objective is to develop DPs as part of design theory that provide prescriptive guidance to build digital commons. The second objective is to instantiate the DPs by building an ITSM digital

commons. The objectives are underpinned by the following research questions.

RQ1: What is the current state of the ITSM research landscape that deals with multi-process complexity?

RQ2: What is the current state of knowledge commons within the KM research landscape?

RQ3: *How can digital commons DPs be developed that are relevant to IS practitioners?*

RQ4: How can the relevance and usefulness of ITSM digital commons be assessed?

Each research question is addressed in the thesis as follows:

RQ1: What is the current state of the ITSM research landscape that deals with multi-process complexity?

RQ1 is addressed through the publication 'IT service management knowledge ecosystem–literature review and a conceptual model' (Ramakrishnan et al. 2018).

This research studied commons and knowledge commons, a popular economic theory. The term, knowledge, is used to describe data, information, knowledge, innovation, and community practices. The SLR systematically analysed how high-quality knowledge management (KM) journals addressed knowledge commons with a focus on innovation-centricity (Ramakrishnan, Shrestha & Soar 2021). The SLR concluded that the application of commons in KM literature covers diverse areas, including Intellectual Property, Knowledge Cities and Industrial Commons, that are related to innovation. The study found that extant literature does not address innovation-centric knowledge adequately.

RQ2: What is the current state of knowledge commons within the KM research landscape?

RQ2 is addressed through the publication '"Innovation centric knowledge commons—a systematic literature review and conceptual model"' (Ramakrishnan, Shrestha & Soar 2021).

RQ3: *How can digital commons DPs be developed that are relevant to IS practitioners?*

RQ3 is addressed through the publications, 'Development of design principles for platform enabled knowledge commons with an expository instantiation' and 'The development and application of epistemic logic driven design principles for innovation-centric knowledge commons'.

The publications discuss the design of an ITSM digital commons instance that is referred to as Service-Symphony (Ramakrishnan 2019), a purpose-built ITSM digital commons that is available in the public domain and being used by practitioners and students. The key theoretical contribution of this research is the development of DPs from multiple perspectives. This chapter describes the systematic approach to developing the DPs.

The first section discusses the DPs from a knowledge governance perspective. The approach commenced with identifying a generic knowledge commons theory and tailoring it to suit the IS practice. The DPs are applied in designing the ITSM digital commons and are evaluated by Solution Architects who also assessed the DPs for reusability. The second section discussed the DPs from an epistemic dimension's perspective. The evaluation is carried out through web analytics.

RQ4: How can the relevance and usefulness of ITSM digital commons be assessed?

RQ4 is addressed through the publications, 'Inclusion of complementary industry knowledge in IT service management curriculum – a case study' (Ramakrishnan, Shrestha & Soar 2020) and 'Achieving industry-aligned education through a digital commons: a case study' (Ramakrishnan et al.

2022). DSR advocates the rigorous evaluation of artefacts (Peffers et al. 2012; Venable, Pries-Heje & Baskerville 2016). Venable, Pries-Heje and Baskerville (2016) proposed a Framework for Evaluation in Design Science Research (FEDS). Paper 3 discusses the formative and summative evaluation of ITSM digital commons. The evaluation was done by industry practitioners and students enrolled in the ITSM course at USQ and Google Analytics was used to analyse user behaviour.

1.4 THESIS ORGANISATION

The mapping between research objectives, research questions and thesis chapters is shown in Figure 1-2. This mapping is referred to as 'thesis compass' and used as a navigation aid while studying the thesis.

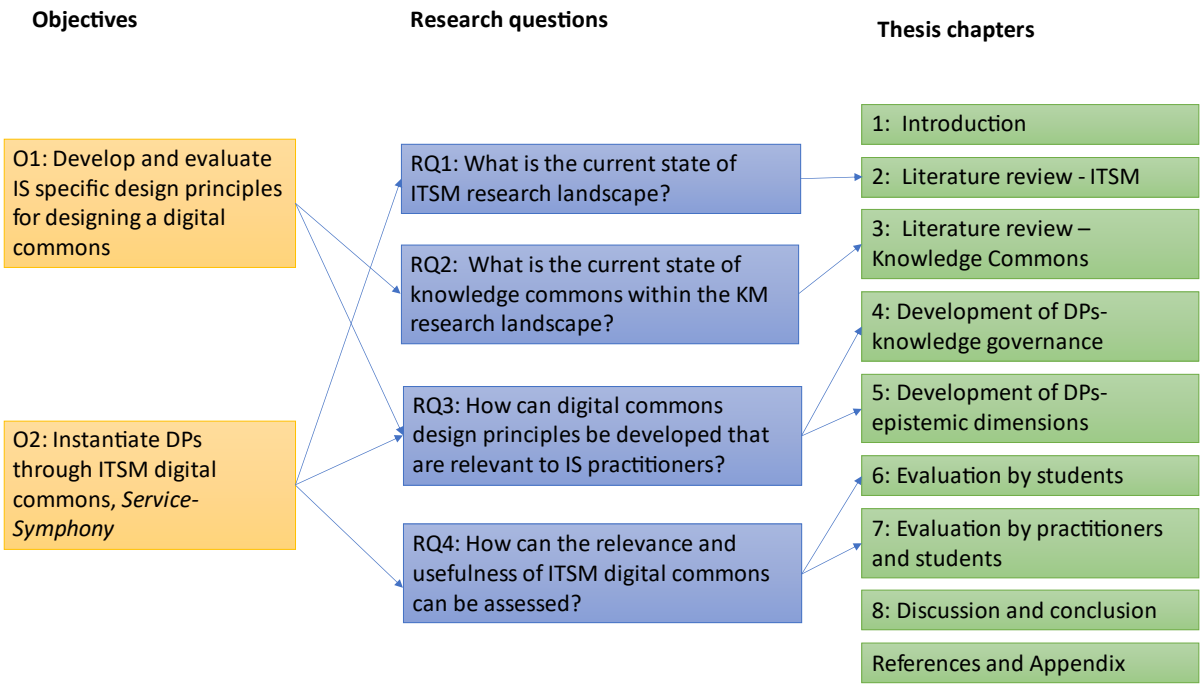

FIGURE 1-2 THESIS COMPASS: MAPPING BETWEEN THE OBJECTIVES, RESEARCH QUESTIONS AND THESIS CHAPTERS

The thesis chapters address the research questions through journal and conference publications.

Table 1-2 shows the thesis chapters and the corresponding publications. This thesis has been written following the guidelines for a Thesis by Publication provided by the University of Southern Queensland (USQ).

The core publications are accepted or undergoing review by high-quality peer-reviewed journals. The conference publications complement the journal publications in the presentation of a coherent, logical narrative.

TABLE 1-2 THESIS CHAPTER AND PUBLICATIONS MAPPING

Thesis Chapter	Publication Title	Journal/Conference
2: Literature review - ITSM	'IT service management knowledge ecosystem–literature review and a conceptual model' (Ramakrishnan et al. 2018)	*Proceedings of the 29th Australasian Conference on Information Systems (ACIS 2018)*
3: Systematic Literature Review-Knowledge Commons	'Innovation centric knowledge commons—a systematic literature review and conceptual model' (Ramakrishnan, Shrestha & Soar 2021)	*Journal of Open Innovation: Technology, Market, and Complexity*
4: Development of DPs for knowledge governance	'Development of design principles for platform enabled knowledge commons with an expository instantiation'	Under review with *Journal of the Association of Information Systems (JAIS)*
5: Development of DPs for epistemic dimensions	'The development and application of epistemic logic driven	Under review with *Decision Support Systems* journal

	design principles for innovation-centric knowledge commons'	
6: Evaluation - Students	'Inclusion of complementary industry knowledge in IT service management curriculum – a case study' (Ramakrishnan, Shrestha & Soar 2020)	*Proceedings of the Pacific Asia Conference on Information Systems (PACIS 2020)*
7: Evaluation – Students and practitioners	'Achieving industry-aligned education through a digital commons: a case study' (Ramakrishnan et al. 2022)	*Journal of Computer and Information Systems (JCIS)*

The thesis chapters are organised as follows:

Chapter 1: This introductory chapter provides an overall context and background of the research including the problem statement, aim and objectives of the study, significance of the research and the structure of the thesis.

Chapter 2: In this chapter, the problem of multi-process complexity is introduced and how the current research landscape deals with the problem. A conference paper provides a comprehensive overview of the research gap and the contextual model.

Chapter 3: This chapter introduces the solution space - the knowledge commons through a published journal article. The publication highlights

the significance of the knowledge commons theory and its diverse applications. The knowledge commons theory is the management theory used to derive the IS-specific DPs.

Chapter 4: This is the core chapter of this thesis. This chapter articulates how the IS-specific DPs, termed PEKC DPs were derived using the knowledge commons DPs. The chapter also describes how the DSR methodology was tailored to develop the DPs and IS artefact iteratively. The evaluation of the DPs is another significant discussion in this chapter.

Chapter 5: The second paper in this chapter describes the development of DPs from the epistemic dimension's perspective. The paper articulates the development DPs that are underpinned by epistemic logic.

Chapter 6: Evaluation is a key component of DSR research. The ITSM digital commons developed as part of this research were used by the practitioner community and the student community. This chapter presents the evaluation by the student community.

Chapter 7: This chapter presents the evaluation by the practitioners and student community. The use of ITSM digital commons was analysed using the connectivism learning theory. The chapter advocates the use of knowledge commons as a continual learning aid for students and bridge knowledge gap between industry and academic learning.

Chapter 8: This chapter summarises the key findings and discussion of the research and presents the contributions to theory and practice. The limitations of the study and areas for further research are also discussed in this chapter.

1.5 SIGNIFICANCE OF THE CONTRIBUTION TO THE PRACTICE

The contribution of this research is significant to ITSM practitioners who play a pivotal role in the organisations. The broader ITSM community is a global community with an estimated population of more than half a

million practitioners. The community comprises consultants, practice managers, auditors, project managers, DevOps professionals, service desk professionals, technology providers, training providers, certification bodies, students and higher education institutions. Ramakrishnan et al. (2018)provide a model in which the process frameworks, technology tools and training community actors interact with each other to maintain a symbiotic relationship within the ecosystem. The ITSM knowledge ecosystem comprising process frameworks, tools and skills and the different actors is represented in Table 1-3.

TABLE 1-3 KEY STAKEHOLDER WITHIN THE ITSM KNOWLEDGE ECOSYSTEM (SOURCE: RAMAKRISHNAN ET.AL 2018, P.2)

Knowledge area	Knowledge Lifecycle Stage		
	Generation	**Dissemination**	**Consumption**
Process frameworks	Library developers	Professional bodies, symposia, social media, networks	Organisations, consultants, auditors
Tools	Vendors, library	Marketing	Organisations
Training /Skills	Higher education institutions, training providers, skills framework	Higher education institutions, HR trainers, job advertisers	Individuals, training providers, Hiring Managers

The frameworks are supported by professional membership forums and there are different forums to address the needs of various professional interests. For example, IT Governance professionals are supported by ISACA (which was previously known as Information Systems Audit and Control Association) with a membership base of 159,000 audit and security professionals spread over 188 countries (ISACA 2019). The SM generic practice is supported by ITSMF which has 40,000 individual members and 6000 member companies (ITSMF_International 2020). The

project management professionals are supported by the Project Management Institute (PMI) with half a million members making it one of the world's largest membership-based professional societies (PMI 2019).

Technology plays a critical role in implementing the frameworks. Service Management frameworks have mature technology tools support (Gartner 2019). The research advisory company Gartner (GartnerForecast 2019) estimates that global spending on IT Services for 2020 will be around USD 1,088 billion, with a predicted growth of 5.5%.

The frameworks and tools have their associated certification schemes. SM frameworks are also included as part of the higher education curriculum (Cater-Steel & Toleman 2007; Bahn et al. 2016).

Service-Symphony was well-received by the global community from its launch in February 2019 with over 121,000 users as of May 2022. Among these users, 15% revisited Service-Symphony (Figure 1-3) which indicates that these users found the knowledge in Service-Symphony relevant to them.

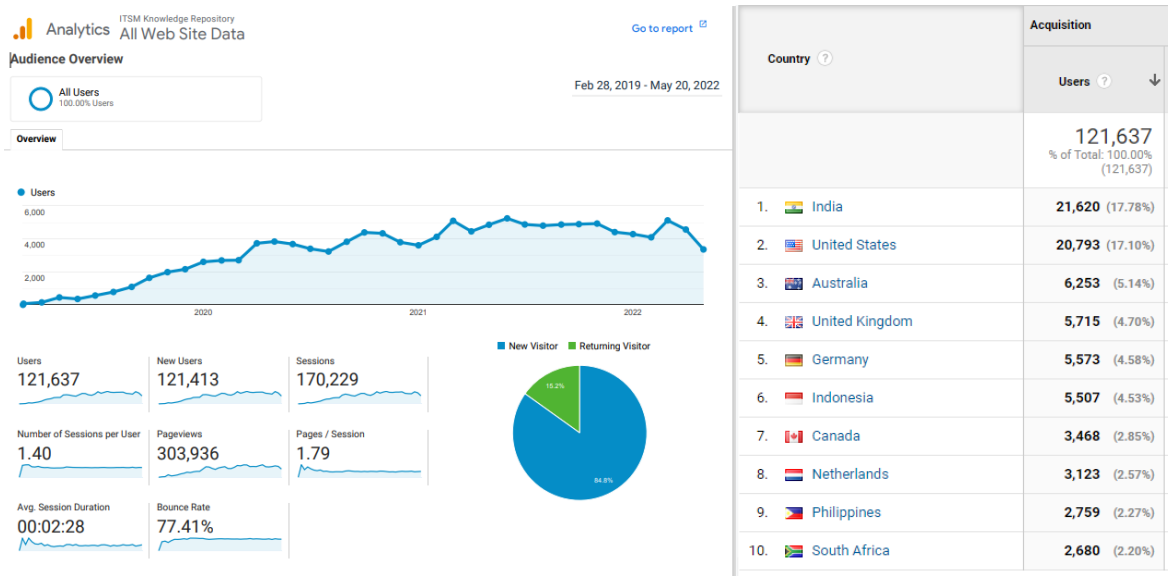

FIGURE 1-3 SERVICE-SYMPHONY WEB ANALYTICS

The traffic is distributed globally with India (17.78%), the United States (17.10%), Australia (5.14%), the UK (4.7%) and Germany (4.58%) in the top five places.

The significance of the research was acknowledged by ITSMF Australia, the professional body of ITSM practitioners, by conferring the Business Innovation Award in 2019.

1.6 SIGNIFICANCE OF THE CONTRIBUTION TO DESIGN THEORY

The seminal paper by Gregor and Hevner (2013a) proposed three levels of knowledge contribution in DSR research, namely:

- Level 1 - Situated instantiations of artefacts such as the DSR contributions;
- Level 2 - Nascent design theory that could include design principles, methods, models, technological rules; and
- Level 3 - Grand theories and mid-range theories.

This research contributes to both Level 2 and Level 1 by developing design principles and applying them to an instantiated artefact that was developed through the research.

Further, the knowledge contribution to DSR can be classified as descriptive knowledge (denoted Ω) that comprises an explanation of natural, artificial, or human phenomena. Prescriptive knowledge (denoted λ) is the knowledge of how to build artefacts.(Gregor & Hevner 2013a; Baskerville, Kaul & Storey 2015; Drechsler & Hevner 2018).

Drechsler and Hevner (2018) distinguish between the design knowledge that is produced and remains within a single DSR project and knowledge that is part of the prescriptive λ-knowledge base. Prescriptive knowledge is the solution knowledge that can be applied to multiple instances.

This research contributes to the DSR theory through the following advances:

- Development of meta-requirements;
- Development of the ten DPs for knowledge governance based on knowledge commons theory;
- Development of three DPs from an epistemic dimensions perspective;
- Evaluation of the DPs by the solution architects based on the framework for evaluation devised by Iivari, Rotvit Perlt Hansen and Haj-Bolouri (2021); and
- Evaluation of the artefact using the FEDS (Venable, Pries-Heje & Baskerville 2016)

Meta-requirements are essential components of a design theory (Walls, Widmeyer & El Sawy 1992; Gregor & Jones 2007)that describe the goals to be addressed for a class of solution (Walls, Widmeyer & El Sawy 1992; Walls, Widermeyer & El Sawy 2004; Kuechler & Vaishnavi 2012).

DPs are regarded as one of the important outcomes of design knowledge (Cronholm & Göbel 2018; Iivari, Hansen & Haj-Bolouri 2018; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). DPs are defined as "knowledge about the creation of other instances of artifacts belonging to the same class" (Kruse, Seidel & Purao 2016, p. 37). The DPs are targeted at the solution designers who would use different ways to apply the DPs to create specific instances. Kruse, Seidel and Purao (2016) identified different ways in which the designers use the DPs, as shown in Table 1-4.

TABLE 1-4 HOW DESIGNERS USE DPS (SOURCE: KRUSE, SEIDEL & PURAO 2016, P.44)

Category	Description
Interpreting scope and content	Designers create meaning and reframe the DPs against the given scenario and their background

Matching with problem space	Designers match the DPs with the given application scenario
Guesstimating missing information	As designers experience incompleteness and degrees of freedom they make assumptions and draw analogies
Projecting into solution space	Designers translate design principles into more specific requirements of form, function, and usefulness
Implanting into the design process	Designers attempt to embed DPs into the design/software development process

This research developed two categories of DPs. The first category addresses the DPs from a knowledge governance perspective. The second category addresses the DPs from an epistemic dimension's perspective. This research argues that both perspectives are critical in designing a digital commons and can be overlooked by IS practitioners as they are as obvious as the mainstream design aspects such as usability and security. There are 10 DPs proposed for knowledge governance. Among these, eight DPs have been tailored from knowledge commons DPs and systematically analysed and modified to suit the IS practitioners. The remaining two DPs were proposed to address the gap to cover the unique characteristics of digital knowledge.

The epistemic dimension DPs are developed to guide the practitioners to consider the aspects of self-knowledge, common knowledge and distributed knowledge. There were three DPs developed and research demonstrates how the features of the digital platform can support DPs. This research also shows how the instance can be measured against the epistemic dimensions based on Web Analytics.

Iivari, Rotvit Perlt Hansen and Haj-Bolouri (2021) point out that though DPs are considered major DSR contributions and acknowledged by quality journals, the relevance to the practice is not established. They caution that if DPs are published without evaluation by the practitioners, the DPs may not be useful in practice. To get feedback from the practitioners, a multi-dimensional reusability framework is proposed that intends to capture the solution designers' feedback in accessibility, importance, novelty, actability and effectiveness dimensions (Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). This research evaluated the reusability of the DPs from solution architects by using the framework of Iivari, Rotvit Perlt Hansen and Haj-Bolouri (2021).

DSR advocates rigorous evaluation of artefacts (Peffers et al. 2012; Venable, Pries-Heje & Baskerville 2016). Figure 1-4 shows a Framework for Evaluation in Design Science Research (FEDS) that is proposed by Venable, Pries-Heje and Baskerville (2016). The framework is organised in two dimensions. The first dimension considers the functional purpose of the evaluation (formative versus summative). The second dimension addresses the paradigm of the evaluation study (natural or artificial).

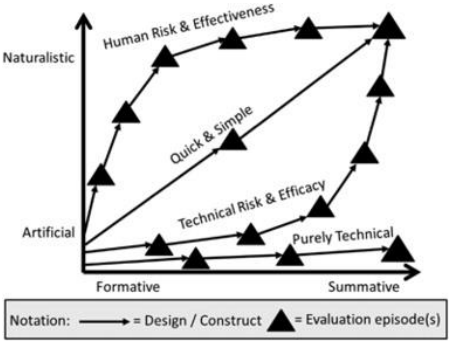

FIGURE 1-4 FRAMEWORK FOR EVALUATION IN DESIGN SCIENCE RESEARCH (SOURCE: VENABLE, PRIES-HEJE & BASKERVILLE 2016, P.80)

The Human Risk & Effectiveness evaluation strategy emphasises formative evaluations early in the process and summative evaluations

once the development is complete. The Human Risk and Effectiveness path is ideal when it is feasible and cost-effective to evaluate the artefact with actual users. The evaluation strategy followed the Human Risk and Effectiveness strategy that included both formative and summative evaluations of the artefact.

This research brings the following significant insights into the DSR knowledge:

- This research has developed DPs for a solution class, the digital commons. As the solution class is critical in this knowledge economy, the underpinning DPs also play a pivotal role as they provide prescriptive guidance to the IS developers. The scope of the DPs is broad so as to cover the socio-technological arena as opposed to focussing only on the technical platform;
- The approach to developing the DPs is also significant as the derivation of the IS DPs from a non-IS external theory is not a typical path of developing the DPs. The IS DPs usually codify the principles to an abstract problem class from an IS artefact. This research's approach of commencing with a management theory, refining the theory to suit IS practice and applying the theory pragmatically to build an IS artefact is novel;
- While the extant researchers acknowledge that the meta-requirements are an important aspect of DSR, there is no systematic process for developing the meta-requirements. This research has used a method by grouping Agile user stories to meta-requirements;
- This research used FEDS framework to evaluate the artefact in a systematic way; and
- The evaluation of the DPs by the practitioner community is a significant step toward closing the gap between the research and practitioner community.

CHAPTER 2 LITERATURE REVIEW - IT SERVICE MANAGEMENT

Publication title	Reference
'IT service management knowledge ecosystem–literature review and a conceptual model' (Ramakrishnan et al. 2018)	Ramakrishnan, M, Shrestha, A, Cater-Steel, A & Soar, J 2018, 'IT service management knowledge ecosystem–literature review and a conceptual model', *Proceedings of the 29th Australasian Conference on Information Systems (ACIS 2018)*, Australian Association for Information Systems, https://doi.org/10.5130/acis2018.bu.

Introduction

This chapter introduces the ITSM knowledge ecosystem comprising process frameworks, tools, and skills. The challenge of having multiple process frameworks in the ecosystem causes confusion and inefficiency and the extant researchers attempt to address the complexity through mapping and harmonisation. The paper presents an alternative approach to the extant research by proposing a digital commons (referred as ITSM knowledge commons in the paper) and a conceptual model. The thesis compass of this chapter is shown in Figure 2-1.

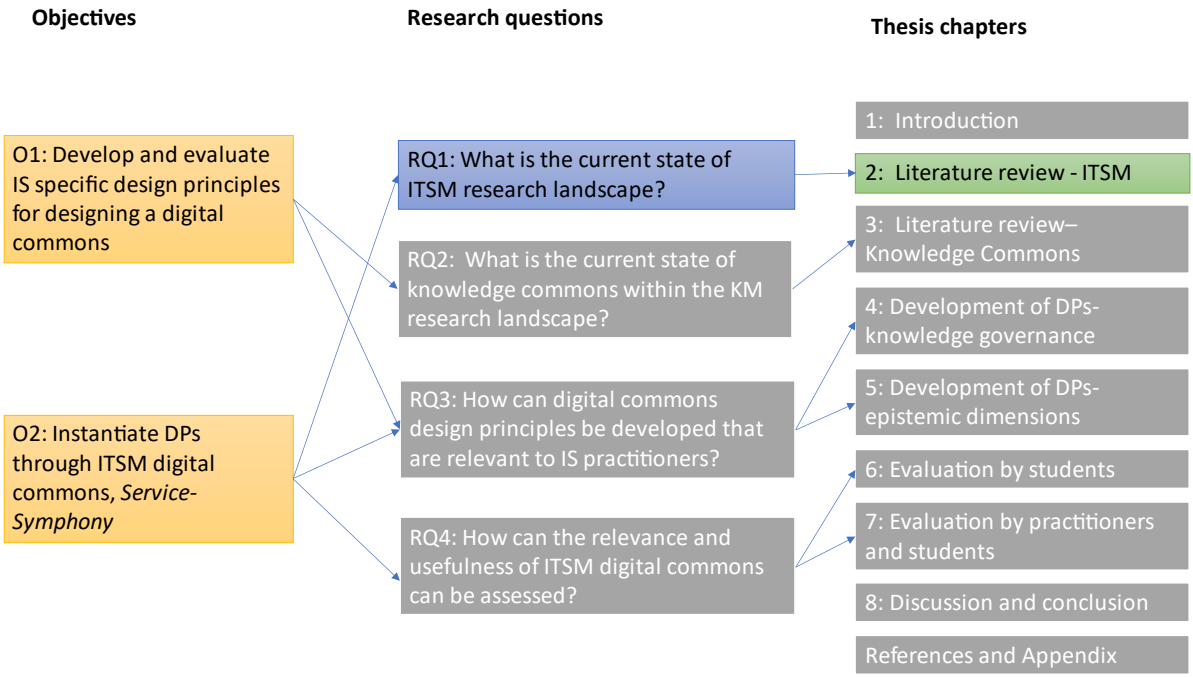

FIGURE 2-1 THESIS COMPASS - CHAPTER 2

IT Service Management Knowledge Ecosystem – Literature Review and a Conceptual Model

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Abstract

Information Technology Service Management (ITSM) is a customer-centric approach to manage IT Services in order to provide value to the business. The ITSM Knowledge ecosystem comprises multiple knowledge areas including process frameworks, technology tools and skills. Organisations struggle to comprehend the ecosystem due to the dynamic nature and volume of the business technology environment. A Systematic Literature Review was conducted to understand the state of the current research in ITSM knowledge ecosystem. The review indicated that the focus of the existing research is skewed towards process frameworks knowledge area and neglects tools and training. The approach proposed in the extant research fails to provide a holistic view of the ecosystem. To overcome the limitations a conceptual model is proposed based on Knowledge Commons theory.

Keywords ITSM, IT Service Management, ITSM Knowledge Ecosystem, ITIL, Knowledge Commons

1 Introduction

Information Technology Service Management (ITSM) is a customer centric approach to manage IT Services in order to provide value to the business (Taylor 2007). The ITSM knowledge ecosystem comprises multiple knowledge areas including process frameworks, technology tools and skills/training. There are many stakeholders who engage in complex interactions utilising different knowledge areas. Table 1 shows the typical knowledge life cycle stages, the knowledge areas and examples of key stakeholders within the ITSM knowledge ecosystem.

Knowledge area	Knowledge Lifecycle Stage		
	Generation	**Dissemination**	**Consumption**
Process frameworks	Library developers	Professional bodies, symposia, social media, networks	Organisations, consultants, auditors
Tools	Vendors, library	Marketing	Organisations
Training/Skills	Higher education institutions, training providers, skills framework	Higher education institutions, HR trainers, job advertisers	Individuals, training providers, Hiring Managers

Table 1 Key stakeholders within the ITSM knowledge ecosystem

In ITSM practice, there are many complementary process frameworks including, but not limited to, COBIT®, ISO/IEC 20000, Lean Six Sigma, Project Management Body of Knowledge (PMBOK®), PRINCE2®, Agile, SCRUM, TOGAF®, DevOps, CMMI® and ITIL®. Organisations often leverage more than one framework to meet their business objectives (Cater-Steel et al. 2006).

Some process frameworks have an extensive range of technology tools to support their implementation. The tools play a pivotal role in automating the process steps, integrating with other processes and providing a user interface for process execution and control.

Likewise, the process frameworks typically offer relevant skill certifications for practitioners. The certification schemes differ between process frameworks. The process frameworks, tools and skills maintain symbiotic relationships within the ITSM ecosystem.

1.1 Research problem

In a dynamic business technology environment, organisations need to continually look out for a complementary mix of process frameworks, supporting tools and updated skills for their employees. However, the existence of multiple process frameworks causes confusion, inefficiency and ineffectiveness (Heston and Phifer 2011). To address these issues, the research problem "*Within the ITSM Knowledge ecosystem, no single platform that provides a holistic, contemporary view of all knowledge areas exists*" is considered.

The research will design and evaluate a Self-Managing ITSM Knowledge Repository (SIKR). SIKR will be a useful resource for organisations during strategic planning as it provides a comprehensive view of complementary frameworks, tools and competencies. Evaluating the use of multiple frameworks within organisations is outside the scope of the research.

2 Literature Review

The research follows the Design Science Research (DSR) methodology (Hevner 2004) . As part of the DSR methodology, a Systematic Literature Review (SLR) is conducted to understand the current state of research knowledge. The SLR addresses the following questions:

- How is the research coverage of knowledge areas distributed?
- What are the primary techniques used to harmonise multiple process frameworks?
- Are these techniques suitable for modelling ITSM knowledge ecosystem holistically?

SLR is a structured and rigorous approach to conduct a literature review (Kitchenham et al. 2009). This research uses the SLR strategy to define the search approach, inclusion and exclusion criteria, data collection and analysis. Among the ITSM process frameworks, ITIL is the most widely adopted framework (Marrone et al. 2014). As ITIL framework spans across the entire ITSM Lifecycle, "ITIL" is used as the bridging keyword in the literature search. To cover additional relevant research papers, the

search terms "ITSM" and "IT Service Management" are included. Table 2 shows the summary of the literature review strategy.

Criteria	Search terms
Search keyword combinations	(ITIL AND COBIT) OR (ITIL AND "Six Sigma") OR (ITIL AND Lean) OR (ITIL AND CMMI) OR (ITIL AND Agile) OR (ITIL AND DevOps) OR (ITSM OR IT Service Management)
Databases	Google Scholar, ACM Digital Library, Applied Science and Technology Source Ultimate, Business Source Ultimate, IEEE Xplore - IET
Language	English
Article type	Academic journals, Conference papers
Options	Scholarly (Peer reviewed) Publications, Full Text, References available, conference papers
Date Range	Jan 2000 to June 2018
Inclusion Criteria	Papers on process frameworks with specific focus on integration/ harmonisation of multiple process frameworks
Exclusion Criteria	Papers outside identified process frameworks; focused on only one framework; those do not include any analysis of the overlap/integration between the process frameworks

Table 2 Literature review strategy

The search found 654 papers that satisfied the search criteria. The paper title and abstracts were screened reducing the set to 67 papers that discussed multiple process frameworks. Duplicate papers and papers that discussed only one framework were rejected. These 67 papers were studied to select 41 papers to be included in literature review based on inclusion criteria outlined in Table 2. The shortlisted literature comprises 15 journal articles and 26 conference papers as listed in Appendix A. To analyse the results the codification approach presented in Table 3 was followed.

Code	Description	Value
Knowledge area	The predominant knowledge area discussed in the research	Process, skills, tools
Process framework coverage	The process frameworks discussed in the research	ITIL, COBIT, CMMI, ISO, DevOps, Lean, Agile, Six Sigma, PMBOK
Process integration approach	Approach to describe the relationships between process frameworks	Mapping, combination, ontology

Table 3 Codification approach

3 Results and Discussion

The knowledge areas were classified as process frameworks, tools and skills. The result indicates that 38 out of 41 included articles addressed the process framework area. The process framework research is focussed on developing a conceptual process model, a map or ontology. Only three papers discussed the issue of skills and no research was found in the tools category. The integration approaches can be broadly classified into mapping and structured ontology. Mapping is a technique of describing the relationship between related processes. Mapping was used by 23 papers to understand the relationship between process frameworks. The structured ontology provides a more formal approach to define the relationship between two entities. Pardo et al. (2013; 2012; 2014) proposed techniques for ontology mapping. The ontology-based approach would suit for process harmonisation of two to three frameworks. Since the ontological model is based on reductionist approach, it cannot harmonise large number of process frameworks due to the inability in managing large amounts of information (Mejia et al. 2016). The summary of findings to research questions is provided in Table 4.

Research question	Findings
How is the research coverage of knowledge areas distributed?	92.7% Process Frameworks, 7.3% Skills, 0% Tools

What are the primary techniques used to integrate multiple process frameworks?	Mapping, Ontology
Are these techniques suitable for modelling ITSM knowledge ecosystem holistically?	The techniques are not suitable for holistic modelling

Table 4 Literature review summary

4 Conceptual Model

The limitations identified through the SLR include the inadequate coverage of tools and skills and inability of mapping/ontological approaches to provide a holistic view of the ITSM knowledge ecosystem. To address these limitations a fundamentally different approach is proposed based on Knowledge Commons theory (Hess and Ostrom 2007).

The term "Commons" is defined as “a general term that refers to resource shared by a group of people” (Hess and Ostrom 2007) . The Commons economic theory is applied in the study of shared natural resources such as water resources, forests, fisheries, wildlife, knowledge management, and Free/open-source software (FOSS) (Macbeth and Pitt 2015). Institutional Analysis Development (IAD) Framework was proposed by Ostrom (1999) to systematically analyse the Commons. Frischmann et al. (2014) argued that the IAD framework needs to be tailored to suit knowledge commons. Drawing inspiration from IAD, this research proposes an alternative conceptual model of Knowledge Commons shown in Figure 1. The conceptual model consists of technical layer, community layer and usage layer. The technical layer is a platform for storing the knowledge artefacts. A practitioner community will contribute to the knowledge creation and governance of the repository. The usage layer will include knowledge consumers.

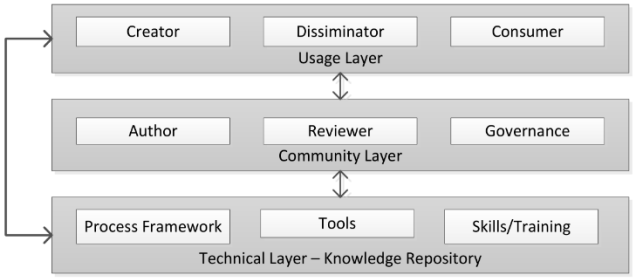

Figure 1 ITSM Knowledge Commons Conceptual Model

5 Conclusion and Future Research Directions

The literature review indicates that the existing research approaches fail to provide a holistic view of the ITSM Knowledge ecosystem. To overcome the limitations of the current research, a conceptual model based on Knowledge Commons is proposed. The conceptual model’s practical and theoretical implications will be explored in the research. Based on the conceptual model, the research will develop a Self-managing ITSM Knowledge Repository (SIKR) using DSR methodology. The suitability and tailoring of DSR will be addressed by the research. In addition, the research will contribute to existing ITSM literature and position the results in current debate on ITSM. The research will be relevant to ITSM practitioners as SIKR is expected to provide a reliable knowledge platform.

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Von Solms, B. 2005. "Information Security governance: COBIT or ISO 17799 or both?," *Computers & Security* (24:2), pp 99-104.

Wickboldt, J.A., Bianchin, L.A., Lunardi, R.C., Granville, L.Z., Gaspary, L.P., and Bartolini, C. 2011. "A framework for risk assessment based on analysis of historical information of workflow execution in IT systems," *Computer Networks* (55:13), pp 2954-2975.

7 Appendix A: Analysed Research Papers in SLR

Authors	Coverage	Knowledge area	Approach
(Berrahal and Marghoubi 2016)	Lean, ITIL	Process	Mapping
(Bahn et al. 2016)	Agile, DevOps	Skills	Curriculum
(Cater-Steel and Toleman 2007)	ITIL, ISO/IEC 20000	Skills	Review of skills
(Cater-Steel et al. 2006)	ITIL, COBIT, CMMI, ISO 9001	Process	Survey
(Ehsan et al. 2010)	PMBOK, CMMI, ITIL	Process	Mapping
(Ekanata and Girsang 2017)	COBIT, ITIL	Process	Mapping
(Evelina et al. 2010)	ITIL, COBIT, CMMI, ISO 9000	Process	Mapping
(Heschl 2008)	COBIT, ITIL	Process	Mapping
(Heston and Phifer 2011)	ISO 9001:2000; Lean Six Sigma; CMMI; ITIL; ISO 27001	Process	Combine
(Huang et al. 2009)	COBIT, ITIL, ISO/IEC 27002	Process	Mapping
(Jeners et al. 2012)	CMMI, ITIL, COBIT	Process	Model- metrics
(Jeners et al. 2013)	ITIL, COBIT, CMMI	Process	Integration
(Karkoskova and Feuerlicht 2015)	ITIL, COBIT, MBI	Process	Mapping
(Kundu et al. 2011)	CMMI, Lean	Process	Mapping
(Kusumah et al. 2014)	COBIT, ITIL	Process	Mapping
(Latif et al. 2010)	ITIL, CMMI, PRINCE2, PMBOK, COBIT	Process	Mapping
(Lin et al. 2009)	CMMI, Six Sigma	Process	Combined
(Lino and da Silva 2008)	Lean, ITIL	Process	Unclassified
(McCarthy et al. 2015)	DevOps, ITIL	Process	Architecture
(Mejia et al. 2016)	ITIL, COBIT, CMMI, Six sigma	Process	Mapping
(Năstase et al. 2009)	COBIT, ITIL, ISO/IEC 27002	Process	Mapping
(Oktadini and Surendro 2014)	ITIL, Six Sigma	Process	Mapping
(Pardo et al. 2012)	ITIL, ISO, CMMI, COBIT	Process	Ontology
(Pardo et al. 2013)	CMMI, ITIL, COBIT, SWEBOK	Process	Ontology
(Pardo et al. 2014)	CMMI, ISO, ITIL, COBIT, RiskIT	Process	Mapping
(Parvizi et al. 2013)	ITIL, COBIT	Process	Unclassified
(Pillai et al. 2014)	ITIL, Lean Six Sigma	Process	Action research
(Pinheiro and Misaghi 2014)	Lean, ITIL, CMMI, COBIT	Process	Mapping
(Pirta and Grabis 2015)	ITIL, COBIT, ValIT	Process	Combine
(Pricope and Lichter 2011)	Generic	Process	Architecture
(Ramachandran 2013)	CMMI, ITIL, PMPOK, Six Sigma	Skills	Mapping
(Sahibudin et al. 2008)	ITIL, COBIT, ISO/IEC 27002	Process	Mapping
(Sánchez Peña et al. 2013)	ITIL, COBIT, EFQM	Process	Mapping
(Sheikhpour and Modiri 2012)	COBIT, ISO/IEC 27001	Process	Mapping
(Stroud 2010)	COBIT, ITIL	Process	Mapping
(Tajammul and Parveen 2017)	ISO27001, PRINCE2, COBIT, OPM3, CMMI, ITIL	Process	Mapping
(Tshinu et al. 2008)	ITIL, COBIT, CMMI	Process	Combine
(Verlaine et al. 2016)	ITIL, Agile (SCRUM)	Process	Mapping
(Veronica and Suryawan 2017)	ITIL, COBIT	Process	Literature Review
(Von Solms 2005)	COBIT/ISO17799	Process	Mapping
(Wickboldt et al. 2011)	ITIL, PMBOK, COBIT, M_o_R	Process	Combine

Copyright

CHAPTER 3 LITERATURE REVIEW - KNOWLEDGE COMMONS

Publication title	Reference
'Innovation centric knowledge commons—a systematic literature review and conceptual model' (Ramakrishnan, Shrestha & Soar 2021)	Ramakrishnan, M, Shrestha, A & Soar, J 2021, 'Innovation centric knowledge commons—a systematic literature review and conceptual model', *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 7, no. 1, p. 35, https://doi.org/10.3390/joitmc7010035.

Introduction:

This chapter introduces the knowledge commons theory. A systematic literature review (SLR) was conducted that reviewed 23 high-quality knowledge management journals and shortlisted 44 papers that discussed knowledge commons. The study shows that there were diverse applications of knowledge commons and identifies a gap in innovation-centric knowledge commons. A conceptual model is developed based on the Institutional Analysis and Development (IAD) framework to apply knowledge commons to support open innovation. The thesis compass of this chapter is shown in Figure 3-1.

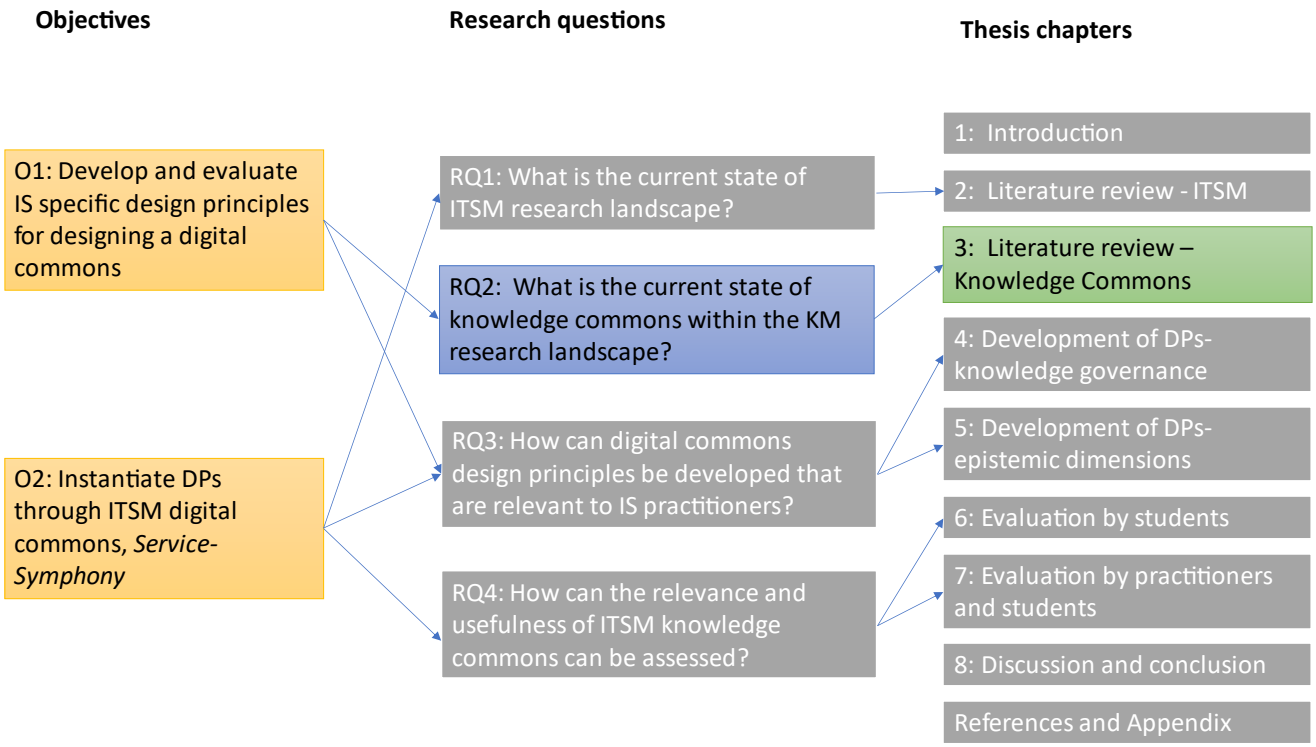

FIGURE 3-1 THESIS COMPASS – CHAPTER 3

Journal of Open Innovation: Technology, Market, and Complexity

MDPI

Article

Innovation Centric Knowledge Commons—A Systematic Literature Review and Conceptual Model

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Abstract: Commons theory is one of the influential economic theories that study the governance of shared resources, including knowledge. This paper provides a comprehensive view of the application of the concept of the commons towards supporting innovation in the Knowledge Management (KM) literature. A systematic literature review identified forty-four (44) relevant research papers discussed the commons published in twenty-three (23) high-impact KM journals. The research found that the application of commons in KM literature covers diverse areas, including Intellectual Property, Knowledge Cities, and Industrial Commons, that are related to innovation. The study found that extant literature does not adequately address innovation-centric knowledge. To address the gap, a conceptual model is presented to apply the Institutional Analysis and Development (IAD) framework to Open Innovation.

Keywords: open innovation; knowledge commons; institutional analysis and development (IAD) framework; systematic review

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1. Introduction

Knowledge plays a central role in the world economy [1–3]. Economies are more strongly dependent on the production, distribution, and use of knowledge than ever before [4]. As the world is facing challenges of a pandemic due to COVID19, opening up the knowledge to promote Open Innovation will further enable us to get practical solutions quicker [5]. Any form of innovation is an entrepreneurial pursuit of creating economic value by combing existing knowledge or creating new knowledge [6–8]. Allen and Potts [9] argue that the innovation process does not just commence with the entrepreneur's new ideas. As a precursor to the innovation process, a common pool of knowledge is desirable for the entrepreneurs to draw information as well as inspiration [10]. One of the applications of Knowledge Commons is the creation of a shared pool of resources. For example, sharing the research on vaccines, ventilator design, and other vital scientific and engineering knowledge is very important to manage the pandemic. In response to the COVID19 pandemic, social scientists working on the Population Council knowledge commons are hosting research on COVID19 and how this virus is presently making an adverse impact on the world's health and economy [11].

Innovation, irrespective of whether it is open or closed, is dependent on the availability of knowledge. To ensure successful innovation, knowledge has to be identified and managed [12]. A study by Hassan and Al-Hakim [13] explores the relationship between Knowledge Management (KM), innovation, and organizational performance and concludes that performance is directly influenced by KM and indirectly influenced by innovation. A similar study by [14] points out that knowledge from customers has a positive impact on both innovation speed and innovation quality as well as operational and financial performances. While the association of innovation and KM to performance has been established in the extant research, the role of commons that support innovation-centric knowledge is not well researched.

We contribute to the research in two original ways by:

- Exploring the application of commons within KM literature through a Systematic Literature Review (SLR). Based on our review, this is the first time such a study has been reported.
- Focusing on innovation and discussing ways the commons framework can be utilized to support Open Innovation.

The rest of the paper is organized into five sections: We provide the background of Commons, Knowledge Commons and how it is related to Open Innovation in the first section. The method section describes the planning and conducting of the SLR. The results section presents the findings of the SLR and analyzes the review findings. In the discussion section, the gaps identified during the review are highlighted and a conceptual model to address the gaps is presented. The conclusion section acknowledges the limitations of the SLR and articulates the future research directions.

2. Commons, Knowledge Commons, and Open Innovation

Commons theory is one of the influential economic theories that study the governance of shared resources, including knowledge [15–19]. The applications of commons in public policy, natural resources management, intellectual property rights, the open-source movement, and legal studies are ubiquitous [15]. The commons can be any resource shared by a group of people that is subject to social dilemmas [20]. Open pasture lands, forests, and rivers are examples of natural commons. Hardin [16], one of the early proponents of commons, argued that managing a commons resource is a "tragedy". He rationalized that in an open pasture, each herdsman will try to keep as much cattle as possible for maximizing the economic return which will, in turn, lead to the deterioration of the pasture. According to Hardin [16], a possible solution to the problem of over-utilization of commons is to privatize the commons. Hardin's view was challenged by Ostrom [18] who argued it is possible to govern the commons successfully through the cooperation of users of the commons property. Ostrom and her team at Indiana University observed many successful commons practices and proposed a governance model. Ostrom's model is underpinned by the principles of self-governance, collaboration, and collective action. During the latter part of Ostrom's career, she collaborated with another researcher Charlotte Hess and extended the application of the natural commons model to knowledge [20].

Open Innovation is a paradigm that proposes that the organizations should both leverage external and internal knowledge to expand the market [21]. The Knowledge Commons is applicable to Open Innovation in three levels: 1. Development of a commons artefact, such as a knowledge repository, that is beneficial to the user community [22–24] 2. Analyzing and attributing the knowledge artefacts, for example, "Creative Commons" licensing model [15,20] 3. Using the rich conceptual framework, design principles of knowledge commons in designing and analyzing Open Innovation systems. We observe that while the first two categories of applications are reasonably researched, the application of the knowledge commons framework to analyze Open Innovations is still underexplored.

Some studies analyze the relationships between knowledge and Open Innovation [25–27]. The relationship between Knowledge Management Systems, Knowledge management capacity, innovation capacity and Open Innovation is explored in a study by Santoro, Vrontis [25]. KMS refers to information systems applied to manage organizational knowledge and to improve the creation, storage, transfer, and application of knowledge. KMC refers to the to retain knowledge over time within the firm. The study concludes that KMS has a direct association with KMC. Moreover, KMS indirectly influences KMC through Open Innovation. Both KMS and KMC are directly associated with the firm's Innovation Capacity. Knowledge Commons provides another perspective of understanding the governance of KMS. In both Closed Innovation and Open Innovation, there is knowledge sharing between different user communities. The KMS can be considered as one of the action arenas in which social interactions happen. Knowledge Commons provides the tools to design and analyze a knowledge governance framework.

SMEs typically start their journey as closed innovation firms [26]. When the firms grow the path to Open Innovation can be in two independent directions namely knowledge partnership and/or business model. The open knowledge innovation can typically be achieved through partnership with research institutes or Universities. The triple-helix model of innovation is based on the collaboration between universities, government, and the firms [28]. The sustainability of the firm will depend upon the path it takes to grow from the closed innovation model [26].

Yun, Won [29] argue that both closed innovation and Open Innovation will coexist in an organization. The closed innovation effort leads to creating a proprietary knowledge stack (PBS) and the Open Innovation effort leads to a shared knowledge stack (SKS). These knowledge stacks impact the firm's performance.

Another interesting study [27] analyses the growth of Alibaba, the dominant e-market provider in China. The researchers suggest that a business dynamics feedback loop, combined with an Open Innovation culture are the key reasons behind the growth of Alibaba.

The studies show that Open Innovation is created by collaborating with knowledge communities within the organization or external to the organization. These human collaborations are subjected to social dilemmas, free-riding and benefit-sharing conflicts, self-managing communities, nested enterprise structure [20]. Knowledge Commons provides insights that will complement the current literature on Open Innovation.

3. Methods

3.1. Planning the Literature Review

Evidence-based research and practice were initially developed in medicine as a more reliable alternative to experts' opinion-based medical advice [30]. In management research, the SLR process is considered evidence-based research. A literature review helps to manage the diversity of knowledge for a specific academic inquiry [31]. The literature review can be broadly organized in three sections, viz., planning the review, conducting the review, and reporting/dissemination [31].

Although the broad intention of the literature review is to systematically collect and present the evidence, there are differences across reviews based on several attributes. Cooper [32] proposes a taxonomy to classify different characteristics for literature review viz., focus, goal, perspective, coverage, organization, and audience. We next present a brief explanation of the taxonomy and an explanation of how we apply this taxonomy in our SLR.

Firstly, the focus deals with the central interest of the researchers. The focus of this research is to understand and analyze the use of commons to support innovation within the KM domain. Second, the goals are concerned with the outcome of the literature review. An obvious goal for a review is to integrate or synthesize the extant literature. The literature review aimed to answer the research question: "How does literature published within the high-quality scholarly KM journals address innovation-centric knowledge commons?" An important goal of this SLR is to identify literature gaps in the extant literature and determine opportunities for future research. Third, the reviewer's perspective plays an important role in the literature review process and presentation. The reviewer does not always need to play a neutral role. The other position can be "espousal" where the reviewer will advocate an alternative view with supporting evidence. The SLR initially takes a neutral perspective in presenting the results of the selected literature. This research takes the position that the established commons theory needs to be used and adapted for KM to support innovation. However, after the completion of the SLR process, while presenting the results, we take an "espousal" position to probe whether there are opportunities to apply the established commons frameworks within KM that have been successfully applied in other disciplines.

Likewise, the coverage can be exhaustive, exhaustive with selected citations, representative citations, or cite the papers that are pivotal to the research topic. The coverage of this literature review is "exhaustive" within the scope of the review. The scope is limited to

quality KM journals. The quality journals are targeted because they " . . . may dramatically influence the development of entire schools of thought, establish the predominance of inquiry methods, facilitate paradigm shifts and form a discipline's identity" [33]. Having a clearly defined scope enables the researchers to cite all the relevant literature instances that have applied commons in their papers.

Moreover, the organization of the presentation of the literature review can be chronological, grouped by concepts, or grouped based on methodology. The organization of this SLR is grouped by concepts that are developed based on common themes on KM, Innovation, and Commons. Finally, the SLR should be written in a language suitable for the target audience. This SLR is intended for scholars within the Innovation and Knowledge management practice.

3.2. Conducting the Literature Review

Brocke, Simons [34] argue that describing the process of searching the literature is important for other scholars to be confident about the results. One of the challenges of any literature review is the selection of keywords to search for. There are multiple interpretations of Commons, including but not limited to, Innovation Commons, Information Commons, Digital Commons, Knowledge Commons, and Library Commons. The researchers wanted to understand all the interpretations of Commons and not limit the search to a particular type of commons. Hence, it was decided to just use "commons" as the keyword.

One of the applications of commons is "creative commons". Since many journal articles are licensed under "creative commons", it was initially difficult to find the relevant research as most search results were not related to the actual research on "creative commons". Therefore, we designed the literature search to distinguish between the research topic on creative commons versus the licensing attribution of creative commons. A preliminary search was conducted using the keyword "commons". We selected the relevant papers that have "creative commons" mentioned in the body (as opposed to license attribution) for subsequent review. Then, the main search was conducted to filter out the term "creative commons" to exclude the papers that were attributed to creative commons licensing.

To identify the quality KM journals, the Scimago journal ranking index [35], and a study by Serenko and Bontis [33] that provided the ranking of KM academic journals were used. Table 1 shows a consolidated list of quality KM journals.

The next step is to identify the databases that enable the search for "commons" excluding "Creative Commons" within the identified quality KM journals. The researchers considered EBSCOhost and Google Scholar to search within the KM journals and found that the EBSCOhost search was not as effective as Google Scholar. For example, when EBSCOhost was used to search within the journal "The Learning Organization" using the search string "JN:The Learning Organization" AND "commons" NOT "creative commons", the query returned only one result. A similar search string in Google Scholar commons—"creative commons" source:"learning organization" returned eleven results. Hence it was decided to use Google Scholar as the preferred search engine to query across all databases for the selected journals. Using the Advanced Search feature of Google Scholar enabled the researchers to target their searches to specific journals. The general format is: Commons—"Creative Commons" Source: "Journal Name"

Once all the target journals were searched, a backward and forward search was performed on each article. The process of backward search refers to reviewing the precedent literature cited in the article. For reverse searching, the reference list of the papers was reviewed that specifically discussed commons. One additional paper was included. Likewise, forward search means reviewing subsequent studies that have cited the article [34]. Since Google Scholar provides the "cited by" list, conducting a forward search used this feature. Within the "cited by" list of literature, three additional papers were selected that discussed commons based on forward-searching. However, none of the additional papers

were published in the selected list of quality KM journals as presented in Table 1. Hence, they were not shortlisted.

Table 1. List of Knowledge Management (KM) Journals used in Literature Review.

No	Journal Name and Publisher	SCImago Quartile 2019	Quality Tier [33]
1	Journal of Innovation and Knowledge (Elsevier)	Q1	Not Assessed
2	Knowledge-Based Systems (Elsevier)	Q1	Not Assessed
3	Journal of Knowledge Management (Emerald)	Q1	A+
4	Journal of Intellectual Capital (Emerald)	Q1	A+
5	Learning Organization (Emerald)	Q2	A
6	Knowledge Management Research and Practice (Palgrave Macmillan)	Q2	A
7	Knowledge and Process Management: The Journal of Corporate Transformation (Wiley)	Q3	A
8	VINE: Journal of Information and Knowledge Management Systems (Emerald)	Q2	A
9	International Journal of Knowledge Management (IGI)	Q3	A
10	Journal of Information and Knowledge Management (World Scientific)	Q3	B
11	International Journal of Learning and Intellectual Capital (Inderscience)	Q3	B
12	International Journal of Knowledge and Learning (Inderscience)	Q4	B
13	Electronic Journal of Knowledge Management (Academic Conferences and Publishing International)	Q3	B
14	International Journal of Knowledge Management Studies (Inderscience)	Q3	B
15	Interdisciplinary Journal of Information, Knowledge, and Management (Informing Science)	Q3	B
16	International Journal of Knowledge-Based Development (Inderscience)	Q2	B
17	Knowledge Management and E-Learning: An International Journal (University of Hong Kong)	Q4	B
18	International Journal of Knowledge-Based Organizations (IGI)	Not Assessed	B
19	International Journal of Knowledge, Culture, and Change Management: Annual Review (Common Ground Publishing)	Q4	B
20	International Journal of Knowledge and Systems Science (IGI)	Q3	B
21	Knowledge Management for Development Journal (Foundation for the Support of KM4DJ)	Not Assessed	B

Figure 1 shows the number of articles found according to the filtering criteria. The initial keyword search column shows the number of papers returned from Google Scholar with the keyword search on "commons" on the selected journals. In the first pass, a filter on excluding "creative commons" was applied. It was followed by studying the abstracts of the papers to exclude the papers that did not discuss commons. Based on this criterion, studies that had weak attributions to commons (for example, reference to digital commons web sites) or a different interpretation of the term commons (for example,

caves and commons, House of Commons) were excluded. Additionally, it was found that "Commons" can also be a part of the author's name (for example, John R Commons) cited in KM literature which is not relevant to the topic. After studying the full papers, the second pass removed the duplicate papers as well as studies with very limited and/or irrelevant discussion on commons, resulting in 44 papers that were included for further analysis in this study, as presented in the next section.

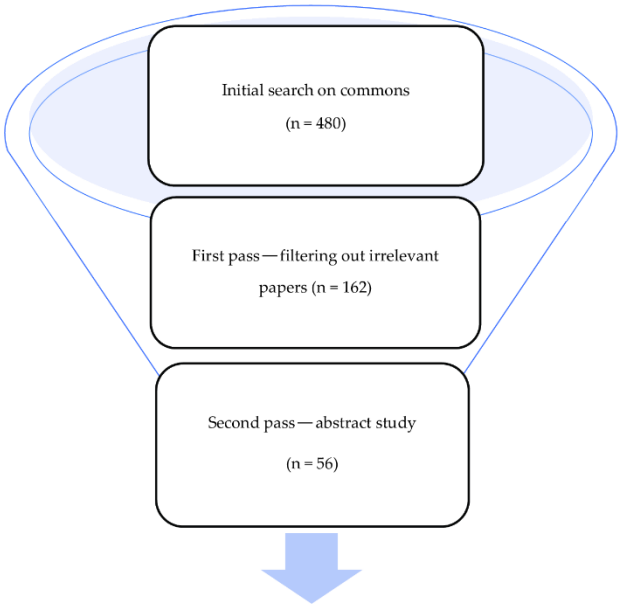

Figure 1. Literature filtering during the first and second pass of the Systematic Literature Review (SLR).

4. Results

The discussion on commons is cited in the KM journals starting from the year 2002. This suggests that the introduction of the concept of commons in the KM literature has most likely started from the study by Carrillo [36]. This paper explores ways in which KM can enrich and be enriched by practices associated with social-level knowledge-based development. Although the paper used the term "global commons" only once, the principles of commons are argued within the context of global development [36]. Figure 2 presents the frequency count of papers on commons and shows the trend that illustrates two peaks observed in the year 2008 and 2019.

The trend shows that the interest in the use of commons in KM peaked in 2008 before slowing down but there is growing interest since 2017. The peak in 2019 suggests that there is a growing interest in the commons research among the KM scholars. The next section discusses the keyword analysis and the depth of coverage of commons in the KM literature.

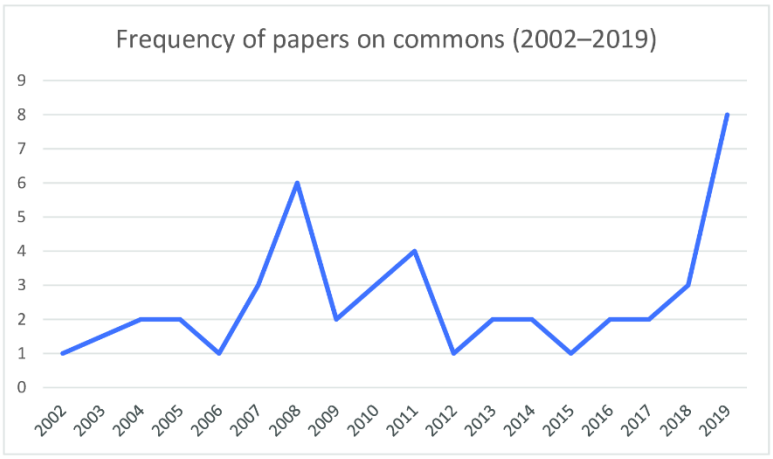

Figure 2. Frequency of publications (2002–2019).

4.1. Depth of Coverage of Commons in the KM Literature

The researchers used the NVivo software [37] for thematic coding and analysis. Using NVivo during the analysis of qualitative data helped the researchers to manage and organize data, manage ideas, query data, visualize, and report from the data [37]. One of the ways to quantify the coverage is to count the number of keyword instances in the paper since keyword density is one of the key parameters of a knowledge resource that may influence positive learning outcomes [38]. Figure 3 highlights that 32 out of 44 (72%) of the papers reviewed include the term commons for less than five times, demonstrating a weak discussion of the commons in the KM literature.

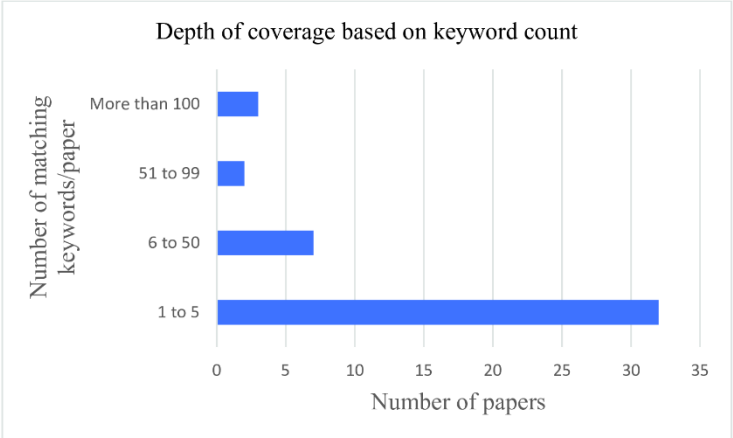

Figure 3. Depth of coverage based on keyword.

The keyword analysis demonstrates that the depth of research on commons is varied. The in-depth studies complementing the keyword search have confirmed that many papers address commons only superficially. The next section attempts to map the KM literature on the topic of studies associated with Commons that support innovation.

4.2. Literature Mapping

To comprehend the KM literature on commons at a holistic level, a two-dimensional mapping is proposed. In the first dimension (horizontal axis in Figure 4), the papers that have discussed innovation ("innovation-centric knowledge"), are differentiated from the papers that discussed knowledge without an explicit focus on innovation ("generic knowledge"). Typically, the "generic" category had a low number of instances of the keyword "innovation". This classification is important because not all types of knowledge are relevant to innovation.

Type of Knowledge Commons / Depth of analysis of Commons	Innovation-centric	Generic
Peripheral	Peripheral: Innovation-centric knowledge commons (n = 22.50%)	Peripheral: Generic knowledge commons (n = 12.27%)
Core	Core: Innovation-centric knowledge Commons (n = 6.14%)	Core: Generic knowledge Commons (n = 4.9%)

Figure 4. Literature mapping of commons in KM research.

Similarly, the second dimension (vertical axis in Figure 4) represents the depth of the analysis of commons in the papers. The peripheral category includes papers that do not focus on commons as a major theme of the study. On the other hand, the core category includes papers that discuss commons as one of their major themes of study. In the core category, the selected papers included "commons" or similar terms (common resources, common good) on the title of the paper itself and closely aligned their argument with the commons concept.

4.3. Core: Innovation-Centric Knowledge Commons

The literature mapping in Figure 4 indicates that only 6 papers out of 44 reviewed literature (14%) discussed commons as a primary model to manage knowledge. The study by [39] explores the scholarly commons, also known as academic commons discussing the collaborative approach in publishing scholarly knowledge, and how modern publications are evolving due to the innovation in Information Systems (IS) platforms, open access, and business models.

The study by Ricciardi, Cantino [40] argues that the common good should be the final goal of organizational learning besides improving the performance of the organization. To develop a conceptual model, the study takes inspiration from Commons theory, adaptive management, and organizational theory. Likewise, the conceptual paper by [41] provides a typology of governance structures to manage knowledge as a global resource in the context of multinational corporations (MNCs). The paper argues that MNCs require enforcement mechanisms to exclude external members to ensure that the benefits of knowledge transfer are optimized for the members. The study focuses on the contribution of intangible knowledge that is difficult to transfer as commodities. This intangible knowledge is intrinsic to the MNCs that creates it. For example, if an organization has contributed to industrial innovation, it is important to understand the organization, its social reputation, and other attributes. The tacit knowledge is socially complex and requires a governance structure built based on social interactions.

Similarly, Ferreira [42] addressed the field of the knowledge commons concerning the challenges in international development, while Corazza, Cisi [43] applied the Commons theory to study meta-organizations. Meta-organizations are groups of organizations linked through membership and share common interests, such as belonging to the same business sector or supply chain. The study suggests that social learning plays a mediating role in the effectiveness of governing the commons.

4.4. Core: Generic Knowledge Commons

These studies discuss commons as a core part of their study but they do not relate how knowledge promotes innovation. The importance of nested institutions and a central knowledge sharing system is stressed in the study by Zeng, Costa [44]. Clean air is considered commons in different provinces of China. This study applies spatial econometric modeling to understand the impact of geographically connected social groups. The province management is not organized as nested institutions. As a result, only geographically connected groups cooperate as there are no incentives to cooperate broadly. Zeng, Costa [44] propose to incorporate nested institutional structure and knowledge sharing across China to improve air quality.

The research by Mas-Tur, Roig-Tierno [45] extends the success factor model of Commons proposed by Cantino, Devalle [46]. The research empirically ranks the success factors through an expert group survey [45]. Alternative Food Networks (AFNs) leverage the concepts of self-organization and self-management aiming to shorten the food supply chain and give customers more power. AFNs offer new ways of managing and sharing knowledge across the network and the paper analyses AFNs through the lens of the theory of the commons [47]. Cultural assets can be viewed as commons as the assets belong to communities and are subjected to neglect and misuse. Similarly, a study by Dameri and Moggi [48] proposes a new business model based on cooperative and participative principles, that can be used by cultural firms to manage the cultural commons.

4.5. Peripheral: Innovation-Centric Knowledge Commons

The majority of the papers (n = 22.50%) fall into this category. This category includes papers that marginally consider the commons concept and relate how knowledge contributes to innovation. The anti-commons debate is an argument whether the expansion of Intellectual Property Rights (IPR), in the form of patents and/or copyrights is limiting the benefits of scientific progress [49]. Patenting is viewed as privatizing the property hence it is against the core-philosophy of commons and hence the term "anti-commons" is used to describe patenting. On the other hand, Van Zeebroeck, De La Potterie [50] point out that there has been a sharp increase in academic patenting and argue that the benefits of academic patents on research seem to exceed their potential negative effects.

Studies have raised concerns that a strong IPR regime can impede innovation, particularly in developed countries [51]. The paper by Cummings, Regeer [52] argues that without Knowledge Commons, the knowledge will be manipulated by commercial interests. The concern is regarding over-protecting the Intellectual Property through copyrights and patents thereby restricting the knowledge to developing countries and development organizations. The alternate approach to anti-commons is creative commons protocols and open-source movement that intend to shift the emphasis back onto collective knowledge creation and sharing [53–56]. Creative Commons redefines IPR by offering copyright that can be shared within a community by acknowledging what aspects of the knowledge can be shared [56].

The terms "intellectual commons" and "learning commons" are used interchangeably while describing the role of modern libraries. In the knowledge economy and digital age, libraries are the main places where people interact to learn and create new intellectual commons [57]. The libraries have diverse learning resources include physical and digital collections, digital repositories, inter-library provision and play a pivotal role in improving the research practices by serving as multipurpose learning commons platform [58,59].

Knowledge commons of cities or "Knowledge cities" imply that the emphasis is placed on the intangible knowledge capital in addition to the traditional focus of physical assets in urban planning [60,61]. Knowledge cities play a fundamental role in knowledge creation and knowledge management [62]. Knowledge cities promote innovation, provide better educational services, contribute to a more sustainable economy, and create a tolerant environment toward minorities and immigrants [61]. Cheng, Choi [62] introduce the concept of subnetworks which takes inspiration from commons theory. The function of subnetworks is to provide benefits to members and exclude non-members from free riding. Youssef and Taibah [61] describe a case study of Jeddah, a Saudi Arabian city being developed as a Knowledge City. The paper discusses an Open Design Studio model that advocates the colocation of three different streams of urban planning and iterative planning.

Similar to the knowledge cities theme, the advantage of territorial colocation is presented in the literature on industrial commons [63,64]. Industrial Commons is derived from natural-resource commons by modifying the attributes to suit the industrial workplace regime. Knowledge societies in developing countries and KM practices applicable to development organizations are an important area in KM literature. KM for development journal (KM4DJ) focuses on this area. Both papers that discussed Knowledge Commons for development [42,52] are published in KM4DJ.

Global Commons are defined as resources that benefit the whole planet, which is managed through the joint effort of international agencies and spawns across multiple governments [36]. The global commons can be natural or man-made. The ozone layer depletion, global warming, financial crisis, and global pandemic are some of the examples where Global Commons can be applied. The World Wide Web can be viewed as a commons that enabled innovation and creativity [65].

Carrillo [36] argues that the concept of KM which is usually applied at the organizational level can also be extended to Knowledge-Based Development (KBD) which is aimed at the societal level. The rationale for KM is to leverage the value-generation capacity of individuals, groups, organizations, societies, and nations. The interpretation of value is broad to include all criteria to determine preferred options. With this broad interpretation, KM can be scaled up to manage global Intellectual Capital.

The paper by White, Cardone [66] proposes a framework for practices in selecting, configuring, and supporting the use of collaboration technologies in international development organizations. The term "commons" is used to note an organizational structure where a pool of resources is allocated. The commons are supported by socio-technical platforms for collaboration and information sharing. The study finds the use of commons is beneficial across different functions of the development organization.

4.6. Core: Generic Knowledge Commons

The term "Information Commons" is used to describe the concept of peer-production of knowledge using the Wiki platforms [67]. The case study by Meloche, Hasan [67] describes the development of a Wiki platform within a large manufacturing organization. The study analyses the factors that positively influence the employees to contribute to the knowledge co-creation and sharing. The conservation of protected areas is a challenging issue as there are conflicting priorities of multiple stakeholders communities. A study by [68] applies Multi-Criteria Decision Making (MCDM) methods in two case studies of Spanish national parks. The study observes that the tragedy of commons is a "myth" and community collaboration is a key component of governance.

The game theory aims to analyze the behavior of interacting participants in strategic situations. A study by [69] addresses the issue of tensions in knowledge flows within organizations through the lens of Game theory. The tragedy of commons is considered as one of the dilemmas. A similar study by [70] proposes a game theory model for Public Goods Game where the participation cooperation is voluntary.

Table 2 summarizes the selected literature categorized on the four quadrants discussed earlier.

Table 2. Full list of studies across the four quadrants.

Commons Type	References	Title
Core: Innovation-Centric Knowledge Commons (n = 6)		
Academic Commons	[39]	Scholarly work in the Internet age: Co-evolving technologies, institutions and workflows
Commons-Generic	[40]	Organizational learning for the common good: an emerging model
Tragedy of Commons	[41]	Development and knowledge resources: a conceptual analysis
Knowledge Management for development	[42]	Evolution and future of the knowledge commons: emerging opportunities and challenges for less developed societies
Knowledge Commons-Development	[52]	Proposing a fifth generation of knowledge management for development: investigating convergence between knowledge management for development and transdisciplinary research
Commons-Generic	[43]	Formal networks: the influence of social learning in meta-organizations from commons protection to commons governance
Core: Generic Knowledge Commons (n = 4)		
Commons-Generic	[44]	Paradoxical effects of local regulation practices on common resources: evidence from spatial econometrics
Commons-Generic	[45]	Successful entrepreneurial learning: success factors of adaptive governance of the commons
AFN Commons	[47]	Knowledge transfer driving community-based business models towards sustainable food-related behaviours: A commons perspective
Cultural Commons	[48]	Emerging business models for the cultural commons. Empirical evidence from creative cultural firms
Peripheral: Innovation-Centric Knowledge Commons (n = 22)		
Industrial Commons	[63]	The intellectual capital needs of a transitioning economy
Intellectual Commons	[57]	Knowledge Management in Libraries in the 21st Century
Knowledge Commons	[71]	The unacknowledged parentage of knowledge management
Knowledge Commons-Cities	[62]	Knowledge repositories in knowledge cities: institutions, conventions and knowledge subnetworks
Knowledge Commons-Cities	[61]	Knowledge cities through "open design studio" educational projects: the case study of Jeddah City
Commons-Generic	[72]	Understanding computer-mediated inter-organizational collaboration: a model and framework
Commons-Generic	[65]	Knowledge clusters and knowledge hubs: designing epistemic landscapes for development
Commons-Generic	[73]	Interaction and innovation-reframing innovation activities for a matrix organization
Learning Commons	[58]	Innovative and creative skills for the 21st Century librarian: benefits and challenges in Nigerian academic libraries
Scientific anti-commons	[50]	Patents and academic research: a state of the art

Table 2. *Cont.*

Commons Type	References	Title
Commons-Generic	[66]	Learning 3.0: collaborating for impact in large development organizations
Tragedy of Commons	[74]	Sustainability, complexity and learning: insights from complex systems approaches
Tragedy of Commons	[75]	Explaining and developing social capital for knowledge management purposes
Creative Commons	[53]	The Austrian national knowledge report
Creative Commons	[54]	Beyond the digital divide: a conceptual framework for analyzing knowledge societies
Creative Commons	[55]	Narratives of knowledge and intelligence . . . beyond the tacit and explicit
Creative Commons	[56]	The epistemology of knowledge and the knowledge process cycle: beyond the "objectivist" vs. "interpretivist"
Tragedy of Commons	[76]	Knowledge, knowing, knower: what is to be managed and does it matter?
Global Commons	[36]	Capital systems: implications for a global knowledge agenda
Global Commons	[77]	National intellectual capital: comparison of the Nordic countries
Industrial Commons	[64]	Territorial capital as a company intangible
Industrial Commons	[51]	Intellectual property rights and knowledge sharing across countries
Peripheral: Generic Knowledge Commons (n = 12)		
Tragedy of Commons	[70]	Impact of individual difference and investment heterogeneity on the collective cooperation in the spatial public goods game
Learning Commons	[59]	Digital literacy: Survival skill for librarians in the Digital Era
Tragedy of Commons	[69]	Knowledge dilemmas within organizations: Resolutions from game theory
Commons-Generic	[68]	Innovation and multi-level knowledge transfer using a multi-criteria decision-making method for the planning of protected areas
Tragedy of Commons	[78]	Elements of organizational sustainability
Knowledge Commons-Cities	[60]	Capital cities: a taxonomy of capital accounts for knowledge cities
Tragedy of Commons	[79]	What factors influence knowledge sharing in organizations? A social dilemma perspective of social media communication
Commons-Generic	[80]	Knowledge governance
Tragedy of Commons	[81]	Knowledge sharing: moving away from the obsession with best practices
Information Commons	[67]	Cocreating corporate knowledge with a Wiki
Tragedy of Commons	[82]	Appropriating economic rents from resources: an integrative property rights and resource-based approach
Tragedy of Commons	[83]	Exploring the affective mechanism linking perceived organizational support and knowledge sharing intention: a moderated mediation model

It was identified that the KM literature covers a relatively wide range of applications of the commons concept. However, we also confirmed that only limited papers (n = 6) discuss the core commons concepts and expand its discourse within the KM literature and explicitly link these ideas to innovation. In this light, we further discuss the expansion of the role of the identified literature on innovation-centric knowledge commons next.

5. Discussion

The extant literature acknowledges the relationship between Commons and Innovation only at a conceptual level. The themes Intellectual Capital [57], and scientific anti-commons [50] are related to treating knowledge as an intellectual asset and deal with different approaches to manage knowledge to foster innovation. The concept of Industry Commons [51,63,64] has the same underlying principle of collaboration advocate in the Regional Innovation Systems [28].

We observed that KM scholars relate to commons theory primarily through the "tragedy of commons" argument by Hardin [16]. The tragedy of commons is discussed in 24 papers. It is important to explain the theory progression of commons in more detail to point out the limitations in the existing KM papers.

The tragedy of commons is classified as one of the first-generation collective action theories. Collective action theory deals with a group of individuals, a common interest among them, and potential conflict between the common interest and each individual's interest [84]. The first-generation theories assume that individuals are not capable of achieving joint benefits when left to themselves. First-generation theorists assume the image of atomized, selfish, and fully rational individuals [84].

One of the reasons for the popularity of Hardin is the parables he uses to explain the concepts [85]. The tragedy of commons was explained through a parable of using a common pasture in an English village [16]. While Hardin's work commenced the debate on commons, the flaw in the initial argument on "tragedy" was pointed out by scholars. Hess and Ostrom [20] highlight four points against the "tragedy of commons". The limitations in Hardin's narrative are: (a) the problem of unmanaged open access is different from managed commons; (b) there were no communications assumed between the actors. This assumption is not true in managing the commons; (c) it is assumed that everyone will act only in self-interest. It is overlooked that some participants will try to collaborate; and (d) Hardin offered only two solutions: privatization or government intervention. There are already many alternative successful common models.

On the other hand, the second-generation theorists acknowledge there are multiple types of individuals that exist in an ecosystem, including the ones that are non-selfish and willing to cooperate. Professor Elinor Ostrom is a notable scholar among the second-generation collective action theorists, who was recognized for her work on commons [86]. The body of work she has produced was acknowledged as one that "contributes to some of the most important questions of the twenty-first century . . . ." [86]. Considering the notable work of Ostrom, it is expected that the literature that analyses commons with reasonable rigour would note Ostrom's contribution and build from there. In the current KM literature according to this review, only 18 papers have cited Ostrom's work. More importantly, none of the extant literature has applied the second-generation theory to develop or analyze knowledge commons that support innovation. Therefore, in the next section, we apply the Institutional Analysis and Development (IAD) framework which was developed as part of the second-generation commons research [87,88] to the Innovation-centric knowledge commons. In the next section, we extend the IAD framework to conceptualize Open Innovation Knowledge Commons.

Conceptual Model for Open Innovation Commons

Open Innovation has also significant overlapping concepts with Knowledge Commons. Open Innovation is a distributed innovation process that relies on purposively managed knowledge flows across organizational boundaries, in line with the organization's business

model [89]. Both Open Innovation and Knowledge Commons models share the foundations of creating a collaborative knowledge sharing model.

The Institutional Analysis and Development (IAD) framework is a diagnostic tool that can be used to investigate any systems that have human participation [20]. The IAD has been applied to investigate a wide spectrum of systems such as forest governance [90], ecosystem management [91], natural resource governance [92], and nanotechnology development consortia [93]. Thus the model gives a strong foundation to build the conceptual model for Open Innovation.

The IAD has four distinct components—(1) external variable that includes the resource attributes, participant characteristics and rules in use (2) the action arena where the participants collaborate (3) outcomes and (4) outcomes evaluation [88]. To conceptualize Innovation Knowledge Commons, the logical place to commence the analysis is by defining the outcomes. The innovation outcome depends upon the types of innovation. The type of innovation is a logical starting point as there is a link between the innovation type and the knowledge management practices [94]. In IAD, all the remaining components will be influenced by the type of innovation. There are different ways of classifying the innovation types [95,96]. The research by Rowley, Baregheh [95] provides a comprehensive mapping that classifies the innovation into four types viz., (1) product innovation (2) process innovation (3) position innovation (commercial and marketing innovation), and (4) paradigm innovation. Their research points out there is an overlap between the types of innovation. Moreover, one innovation can trigger other forms of innovation. For example, product innovation may lead to many process innovations. A technology firm leading innovation to position its competitive advantage will need a different Innovation-centric Knowledge Commons ecosystem than a small business trying to optimize the internal processes.

The second step in the design of the Innovation-centric knowledge commons is to focus on the external variables including the participant characteristics, knowledge resource attributes, and operational rules. The participant characteristics can consider both technical and non-technical skills. The knowledge resource can be software code, patent application, an experimental setup, or a simple administrative procedure. The knowledge resource attributes such as confidentiality, integrity, and availability will depend upon the type of innovation. The operational rules will influence how the collaboration between the participants is intended. It is important to note that the commons model strongly advocates the participants to develop and evolve local operational rules.

Third, the action arena is the place where the participants actively collaborate to create an innovative outcome. They are the social spaces where participants "interact, exchange goods and services, solve problems, dominate one another, or fight" [88]. The action arena can be an online technology platform, a physical space, or a combination of the virtual and physical environment. It is important to recognize that the attributes of the technology platform need to align with other components of the Innovation-centric knowledge commons.

Finally, the outcome evaluation is required to ensure that the outcome is aligned with the expectations. Allarakhia and Walsh [93] suggest that knowledge generation, knowledge access, and knowledge usage are some of the evaluation options. The analysis should feed the information back to the participants which could influence some changes to the outcome itself. Figure 5 illustrates our attempt to demonstrate the fusion of KM and Innovation from the lens of Commons that can be executed with IAD as a framework. The resultant outcome is coined as the innovation-centric knowledge commons. The innovation-centric knowledge commons conceptual model is shown in Figure 5.

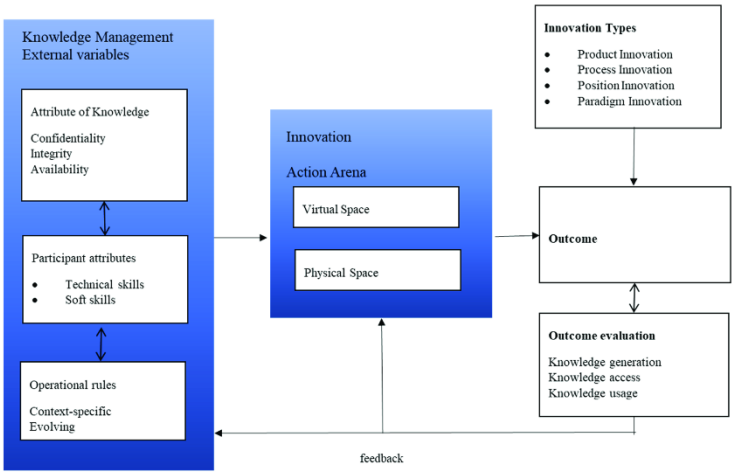

Figure 5. Application of Institutional Analysis and Development (IAD) framework (Ostrom 1999) to conceptualize Open Innovation.

Although other studies have applied the IAD framework to analyze knowledge commons [15,20,93], they have not specifically extended IAD to innovation-centric knowledge commons. By applying IAD to innovation-centric knowledge commons, the conceptual model provides clarity to conceptualize innovation knowledge. The conceptual model addresses the people, technology, and process aspects of the organizational system design. Figure 5 demonstrates linking the innovation outcomes with the KM external attributes using the innovation action arena gives guidance to researchers and practitioners to execute the IAD framework that promotes innovation-centric knowledge commons.

The application of the IAD framework to innovation knowledge opens new avenues of research. Future research can look more deeply into each of the IAD components, viz, innovation outcomes, KM external attributes, innovation action arena, and outcome evaluation.

The IAD framework is scalable and can be applied at various levels. Typically the IAD is applied to study natural resources and policymaking because of its roots. The model presented in Figure 5 can be applied at an organizational and scalable to regional and national levels.

The complexity of Open Innovation increases from firm-level, regional level, national level and global level [97]. Yun and Liu [97] view this hierarchical Open Innovation System as a Complex Adaptive System (CAS). The IAD can be effectively used to analyze the dynamics of such CAS [19].

In future research, we can explore case studies of applying IAD at various levels. An empirical analysis of existing CAS through the IAD model is also an exciting future research possibility.

6. Conclusions

This study answers the question, "How does literature published within the high-quality scholarly KM journals address innovation-centric knowledge commons?" through a systematic literature review. The review found that KM researchers have leveraged commons theory as one of the broad inputs to support their main themes. There are wide-ranging applications of commons in KM literature including Intellectual Capital, Industrial commons, and scientific anti-commons that are directly related to innovation.

The study suggests there are two gaps in the extant research on commons within the KM domain. The gaps are (1) The lack of research and application of second-generation, collective action knowledge commons, and (2) The lack of research in the area of innovation-centric knowledge commons. This research proposes a conceptual model for Open Innovation that shows the relationship between knowledge, commons, and innovation by extending the IAD framework that is part of the second-generation commons theory. Thus, this research addresses both the gaps by demonstrating the application of a second-generation collective-action framework in building innovation-centric knowledge commons.

One of the limitations of this paper is the consideration of KM papers that are published only in the KM journals that met the quality criteria. This selection implies that other relevant research papers that are published outside the listed KM journals are omitted. The researchers interpreting or applying the results of our SLR needs to consider the limitation. The conceptual model is derived by extending the IAD framework to innovation. The model needs to be validated through empirical evidence, such as case studies.

The researchers believe that this is the first SLR paper conducted in KM literature to understand the application of commons to support innovation. This paper is expected to be a reference for future research on commons within the KM discipline. The IAD model discussed in this paper provides a logical starting point for the researchers and practitioners to understand the institutional arrangements and community dynamics in building or analyzing Open Innovation systems.

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CHAPTER 4 DEVELOPMENT OF DESIGN PRINCIPLES – KNOWLEDGE GOVERNANCE

Publication title	Journal
'Development of design principles for platform enabled knowledge commons with an expository instantiation'	Under review with *Journal of the Association for Information Systems* (JAIS)

Introduction

This first section of the chapter describes the development of DPs from a knowledge governance perspective. In this section of the chapter, this research critically reviewed and extended the commons design principles arising from well-established economics theory and formulated Platform Enabled Knowledge Commons (PEKC) design principles to be applied and reused within IS practice. The PEKC design principles were applied in developing the ITSM knowledge commons, the instantiated IS artefact. This research demonstrated the reusability of PEKC design principles through focus group interviews with IS architects. This case study illustrates the complete life cycle of design principles covering conceptualisation, initial formulation, iterative refinement, application to an important real-world instantiation and evaluation by a group of independent IS practitioners. The thesis compass of this chapter is shown in Figure 4-1.

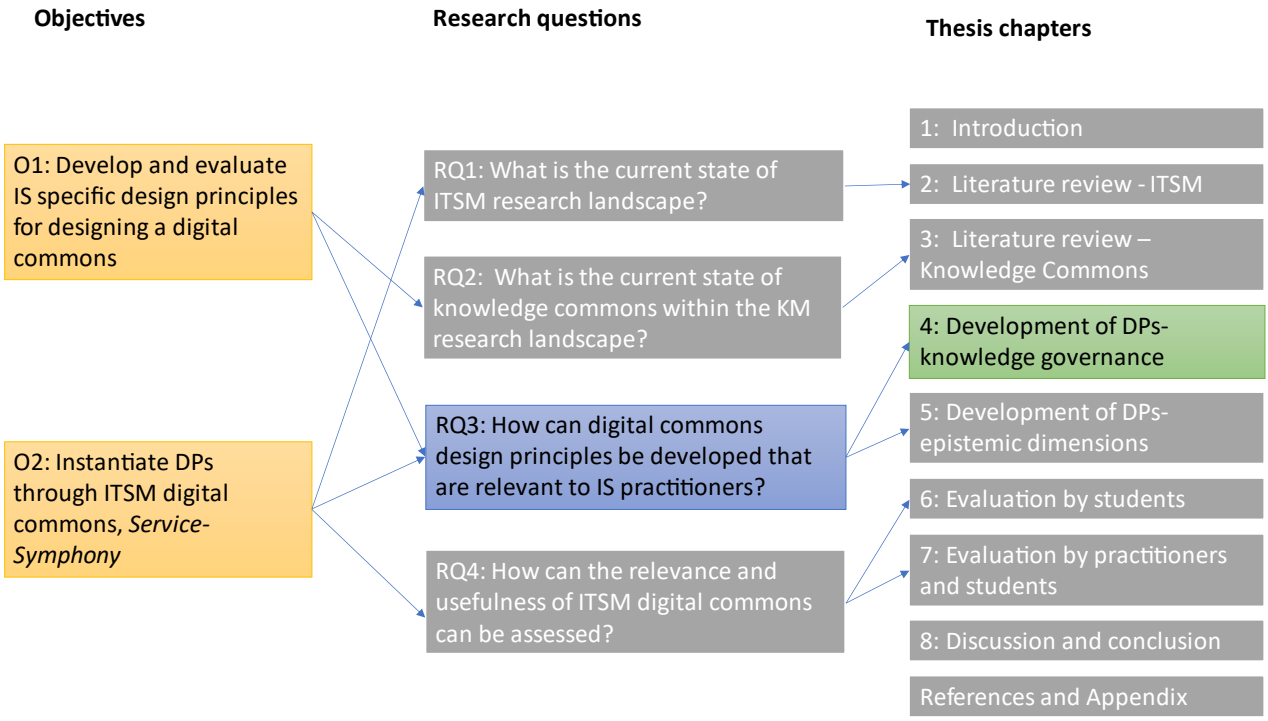

FIGURE 4-1 THESIS COMPASS - CHAPTER 4

Development of Design Principles for Platform Enabled Knowledge Commons with an Expository Instantiation

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ABSTRACT:

Knowledge commons play a pivotal role in knowledge creation and sharing through a digital platform. The motivation for this research was the opportunity to develop a knowledge commons for IT Service Management (ITSM) practitioners. It was found that there were no reusable design principle (DP)s in the IS domain to guide this development. Thus, we critically reviewed and extended the commons design principles arising from well-established economics theory and formulated Platform Enabled Knowledge Commons (PEKC) DPs to be applied and reused within IS practice. The PEKC DPs were applied to the instantiated IS artefact, that we refer as 'Service-Symphony'. Service-Symphony is a purpose-built, public facing knowledge repository developed for the benefit of IT Service Management practitioners and students. This research followed Design Science Research (DSR) paradigm and contributes to the body of the knowledge by establishing a multi-grounded design theory comprising Meta-requirements and DPs. To bridge the theory and practice, we assessed the reusability of PEKC DPs through focus group interviews with IS architects. Our case study illustrates the complete life cycle of DPs covering conceptualisation, initial formulation, iterative refinement, application to an important real-world instantiation and evaluation by a group of independent IS practitioners.

Keywords: Knowledge Commons, IS Knowledge Platform, design principles, Design Science Research

4.1 INTRODUCTION

IS knowledge platforms play a pivotal role in facilitating knowledge collaboration within and across communities. There are several types of online platforms including blogs, online reviews, open-source software development, social media, and wikis (Mindel, Mathiassen & Rai 2018). Each platform type has specific objectives and associated functions to fulfil those objectives. For example, the objective of a blogging platform is different from a wiki platform. However, all types of knowledge platforms share an overriding objective of providing stakeholder value (Mindel, Mathiassen & Rai 2018). These diverse applications of knowledge platforms provide value to stakeholders on different scales, ranging from individual to global benefits such as improving human health and mitigating pandemics including COVID-19 (Reichman, Uhlir & Dedeurwaerdere 2015; Acharya et al. 2020). This research developed a purpose-built, public facing knowledge platform for IT Service Management practitioners and students. The knowledge platform is referred as 'Service-Symphony' in this paper. IT Service Management is a practice that encompasses diverse process frameworks such as IT Governance, strategy, operations, project management, quality management, service improvement and related practices (Cater-Steel, Tan & Toleman 2006; Ekanata & Girsang 2017; Veronica & Suryawan 2017).

To design and manage an IS knowledge platform that provides stakeholder value, it is necessary to design a platform that fulfils both the technical requirements and the stakeholder community's social needs. A substantial body of research analyses the design of knowledge platforms from different perspectives including *affordances* (Gaver 1991; McLoughlin & Lee 2007; Yeo & Arazy 2012), user *interfaces* (Lamberti &

Wallace 1990; Reinecke & Bernstein 2013; Vance, Lowry & Eggett 2015), and *information security* (Roumani & Nwankpa 2020). Similarly, there is another stream of IS agnostic management research that analyses the human behaviours that influence online participation (Majchrzak 2009; Chen, Wei & Zhu 2017; Salehan, Kim & Kim 2017).

This paper aims to bridge the social and technological aspects of IS knowledge platform design by adapting *commons theory*. Commons theory is a prominent economic theory that analyses the sustainability of the sharing of natural resources such as rivers, forests, and fisheries (Ostrom 1990). One of the outcomes of commons theory is the development of design principle (DP)s for knowledge commons (Hess & Ostrom 2007), which extends commons theory by considering knowledge as a shareable resource. Knowledge commons theory to date uses the same DPs that have been developed for natural resources.

Knowledge commons DPs have been used in analysing existing IS platforms such as Wikipedia (Viégas, Wattenberg & McKeon 2007; Forte, Larco & Bruckman 2009; Safner 2016). While the extant research provides a starting point, significant gaps were identified when applying the DPs to design an IS artefact and make the DPs reusable for the knowledge commons class of design problems.

In the IS discipline, the formulation of DPs is one of the salient contributions in conveying design knowledge (Chandra, Seidel & Gregor 2015; Cronholm & Göbel 2018; Gregor, Chandra Kruse & Seidel 2020). The purpose of DPs is to guide the design of different instances of IS artefacts that belong to the same type or class (Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). DPs can be considered as abstract knowledge that is often codified after the artefact is instantiated (Gregor, Müller & Seidel 2013). In contrast, our research commenced with the knowledge commons DPs and refined them during the development and instantiation of the IS artefact. Our approach is described in the Research Methods section.

Knowledge commons is a broad area that can be considered as a problem class that is relevant to IS practitioners. As part of a broader research project, we conducted a systematic literature survey and found that knowledge commons encompass intellectual property, knowledge cities, industrial commons, academic commons, open-source systems, and learning commons (reference removed for review). A subsequent step narrowed the scope to be relevant to the problem we had encountered in IS practice. We defined *platform enabled knowledge commons* (PEKC) as a sub-set of knowledge commons where knowledge creation and consumption are facilitated by an IS knowledge platform.

The second limitation we addressed was to redefine the commons DPs in a language that is relevant to IS practitioners. This criterion is known as accessibility which is defined as "*the degree to which members of the target community can understand and comprehend the set of design principles and whether they are individually and collectively intelligible"* (Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021, p. 292). Further, as the commons DPs were developed in the context of natural resources, we had to explore whether all the original DPs are relevant to IS practice and importantly if there were any missing principles.

To address these limitations of the commons DPs, we considered the research question:

How can we develop PEKC design principles that are relevant to IS practitioners?

This research follows the design science research (DSR) paradigm (Hevner et al. 2004; Baskerville et al. 2018) that is ideally suited for research that focuses on developing IS artefacts (Gregor & Hevner 2013a) to develop Service-Symphony. This research contributes to the DSR knowledge by deriving and applying IS specific DPs that capture the "know-how" aspect of building the IS artefact (Gregor & Hevner 2013a; Gregor, Chandra Kruse & Seidel 2020). The DPs are considered a key part

of design theory (Gregor & Jones 2007; Gregor, Müller & Seidel 2013; Baskerville et al. 2018; Gregor, Chandra Kruse & Seidel 2020)

This paper addresses the evaluation of both the IS artefact and DPs. The IS artefact evaluation was carried out through web analytics and a survey. The DPs were evaluated by target practitioners to ensure that they potentially would find them useful to create solution instances within the class of problems (Iivari, Hansen & Haj-Bolouri 2018; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021).

The remainder of the paper unfolds as follows: the background of ITSM practice and the research landscape are discussed in the next section. A review of the extant research on IS knowledge platforms is addressed in the related literature section. The research methods section explains the adaption of DSR steps to suit this research. The remaining sections are aligned with the research steps of design, artefact evaluation, DPs evaluation and discussion.

4.2 BACKGROUND AND RELATED LITERATURE

This research successfully developed and launched Service-Symphony for the benefit of ITSM practitioners in February 2019. ITSM is a practice that describes a customer-centric approach to managing IT services (Taylor 2007). Service-Symphony serves as a portal for different practitioner communities to obtain a trusted view of state-of-the-art best practices.

<<Reference Removed for review>> proposed a model for the ITSM knowledge ecosystem comprising process frameworks, tools, and skills. The model provides a holistic view of knowledge to the different stakeholder communities. Since the ecosystem consists of many independent knowledge artefacts, it is a challenge to keep abreast of changes as each knowledge community has its own release cycles. Figure 1 shows the release cycles of key frameworks within the date range of the years 2000-2020 that are relevant to ITSM.

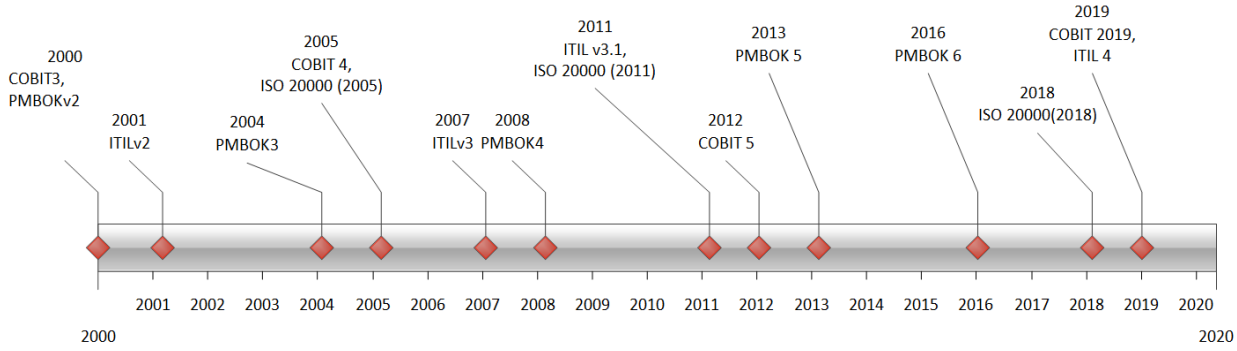

FIGURE 4-2 RELEASE CYCLES OF PROCESS REFERENCE FRAMEWORKS RELEVANT TO ITSM <<REFERENCE REMOVED FOR REVIEW>>

Figure 4-2 shows that release cycles of frameworks are independent of each other, and some frameworks are aperiodic. For example, between the years 2018 and 2020, three related ITSM frameworks – ISO/IEC 20000, COBIT 2019, and ITIL 4 were released. Often organizations are required to implement more than one process framework (Cater-Steel, Tan & Toleman 2006). However, the existence of multiple process frameworks causes confusion, inefficiency, and ineffectiveness (Heston & Phifer 2011). Without the aid of a holistic knowledge repository, it is effort-intensive to study the impact of the new releases and the relationship between the releases within an organization. The academic community also struggles to keep up with the changes within the ITSM knowledge ecosystem (Cater-Steel, Hine & Grant 2010). An academic curriculum that is based on the frameworks needs to carefully assess the impact of the releases and be updated accordingly.

Another challenge in the ITSM knowledge ecosystem is to monitor emerging best practices. For example, the interest in DevOps practice (Ebert et al. 2016) has steadily grown over the years. While there are industry forums and other platforms that can provide a view of emerging trends, the knowledge is often specific to one or two specific interest groups. For example, the DevOps community may discuss specific technologies and practices about DevOps rather than offering a holistic

view across the broader IT practices. Service-Symphony is intended to address this gap by providing a current view of emerging best practices across the entire ITSM ecosystem.

In sum, in the ITSM ecosystem, there are no existing knowledge repositories that provide the required holistic view. Before embarking on the Service-Symphony development, this view was validated in discussions with industry experts, academia, and professional bodies. After the launch of the portal, the positive feedback received from practitioner and student communities reinforced the relevance of having such a knowledge portal.

4.3 OVERVIEW OF COMMONS THEORY

For guidance in designing and developing Service-Symphony, we reviewed the management and IS literature. Commons theory that was developed by Elinor Ostrom (Ostrom 1990; Ostrom et al. 1994; Ostrom 2008) was found to be a good fit as it was a credible management theory and has been applied to comparable knowledge platforms such as Wikipedia.

The term "commons" describes the institutional arrangement of managing a resource shared by a group of people that is subject to social dilemmas (Ostrom 1990; Frischmann, Madison & Strandburg 2014). Hardin (1968) introduced the term "commons" in academic research through his article on the "tragedy of commons". Hardin (1968) explained the tragedy by arguing that in an open pasture, each herder will try to keep as many cattle as possible for maximizing economic return which will, in turn, lead to the deterioration of the pasture. However, Ostrom (1990) observed that there are many successful commons models based on mutual trust between the participating actors that use the commons. The body of work Ostrom has produced was acknowledged as one that "*contributes to some of the most important questions of the twenty-first century….*" (Wall 2014, p. 3) and she was awarded the Nobel prize for her

analysis of economic governance, especially the commons, in 2009. Ostrom's commons theory is underpinned by the principles of self-governance, collaboration, and collective action.

During the latter part of Ostrom's career, she collaborated with another researcher Charlotte Hess and extended the application of the natural commons model to knowledge. Hess and Ostrom (2007, p. 21) observe that knowledge commons is an exciting field that enables us to "*creatively design new systems that tap into the limitless capabilities of digital information technologies*". Knowledge Commons theory has been applied to a wide range of overlapping practices including, but not limited to, public policy, intellectual property rights, legal studies, and innovation (Suber 2006; Frischmann, Madison & Strandburg 2014; Rathwell, Armitage & Berkes 2015; Allen & Potts 2016; Albagli et al. 2018).

In IS practice, the application of knowledge commons theory has been mostly confined to analysing Wikipedia or similar knowledge platforms (Viégas, Wattenberg & McKeon 2007; Forte, Larco & Bruckman 2009; Safner 2016). A noted exception is the research paper by Mindel, Mathiassen and Rai (2018) which unifies the tragedy of the commons and Ostrom's theory to design a polycentric information commons. The polycentric information commons is a conceptual framework balancing collaboration and self-centric human behaviours to develop a sustainable implementation of information commons. The conceptual model was not extended to develop DPs.

One of the contributions of Ostrom's research is the development of governance DPs. The DPs emphasize factors that exist in most robust commons governance organizations and are absent in failed systems (Ostrom 1990).

The commons DPs are : (1) Clearly defined boundaries: (2) Congruence that allows the members to share the benefits and costs proportionally; (3) Collective-choice arrangements that enable members to establish local

rules; (4) Monitoring of member behaviours; (5) Graduated sanctions to regulate member violations; (6) Conflict-resolution mechanisms that are fair; (7) Recognition of rights of group members to self-organize internally; and (8) Nested enterprises that allow a structural hierarchy of groups (Ostrom 1990).

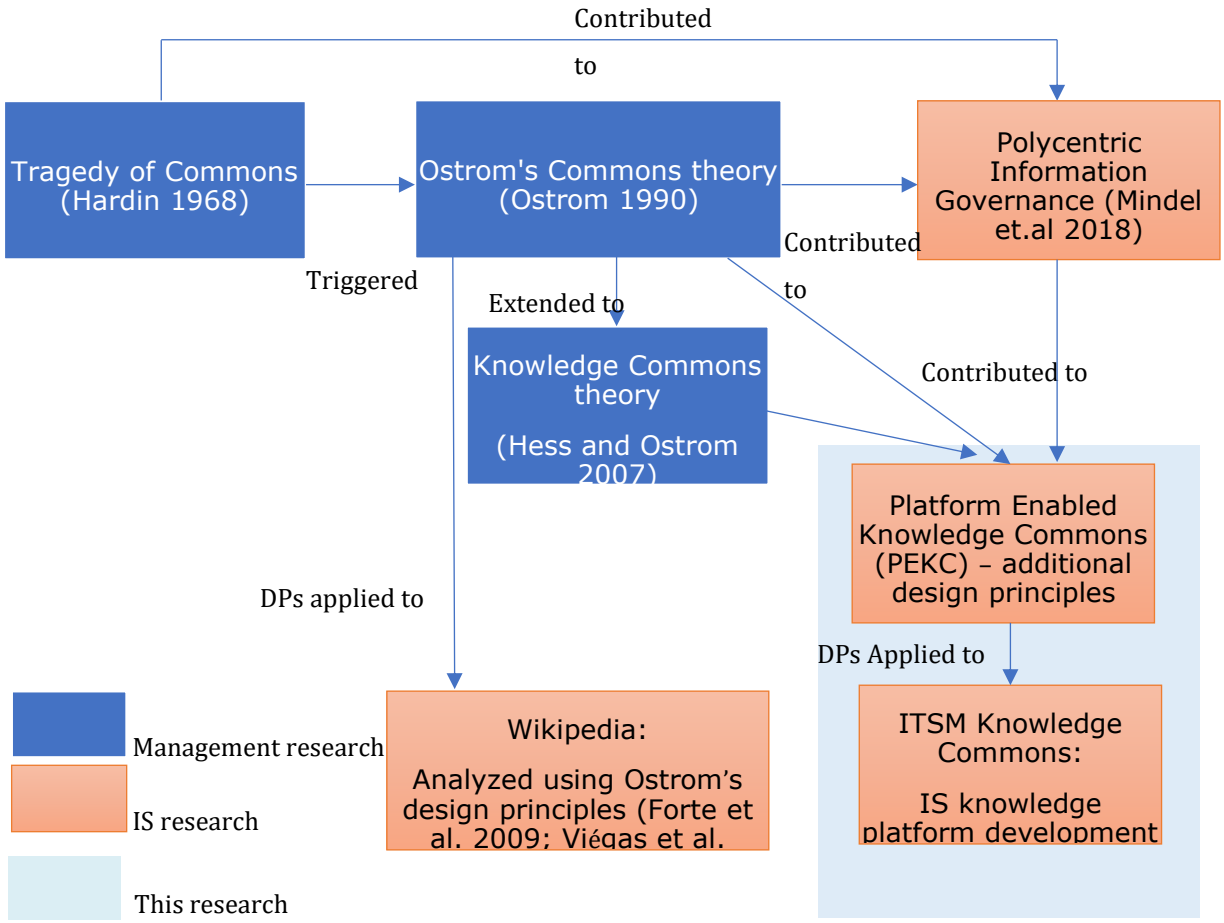

FIGURE 4-3 POSITIONING OF PEKC WITHIN THE COMMONS RESEARCH LANDSCAPE

IS researchers have applied Ostrom's DPs to study the success of the online knowledge collaboration platform, Wikipedia. Viégas, Wattenberg and McKeon (2007) applied four of the eight DPs in analysing wikipedia's featured article (FA) process. Their research found that principles 2, 3, 4, and 6 are applicable in the wikipedia process. In subsequent research, Forte, Larco and Bruckman (2009) analyse the remaining DPs: 1, 5, 7,8.

The studies by Safner (2016), Dourado and Tabarrok (2015) argue that all eight commons DPs apply to Wikipedia.

Figure 2 shows a summary of the Commons research landscape. The prominent body of management literature is the "tragedy of commons" theory arguing for the need for privatization and Ostrom's theory on collaboration and collective action. Hess and Ostrom (2007) treated knowledge as a commons resource and hence extended commons theory to knowledge commons.

The extant IS research is mostly limited to demonstrating the application of natural commons DPs to Wikipedia with an exception of a conceptual model proposed by Mindel, Mathiassen and Rai (2018). However, Mindel, Mathiassen and Rai (2018)'s paper stopped at a conceptual level and did not proceed to a prescriptive level to be used to IS practitioners. We found three major limitations of the extant research in applying Ostrom's DPs.

1. The extant research was limited to examining whether Ostrom's commons DPs could be observed in IS platforms once constructed. This approach would not necessarily reveal additional DPs that may have been introduced by designers.
2. The extant research used the concepts and terminology from Ostrom's commons theory, without any modification that would assist IS practitioners to embrace the DPs
3. Ostrom's Commons DPs have not been applied to the development of any green field IS platform to demonstrate the practical significance of the DPs

This research addresses the identified limitations by:

- Systematically analysing the characteristics of knowledge to propose additional DPs that are not covered in Ostrom's natural commons DPs

- Examining the existing natural commons DPs concepts and terminology and tailoring the principles to suit IS practitioners
- Applying the proposed expanded set of DPs in constructing knowledge commons that are built around an IS knowledge platform
- Evaluation of the DPs from the perspective of practitioners.

4.4 RESEARCH METHODS

This research followed the DSR paradigm. DSR is a research paradigm that addresses the relevance versus rigour gap in information systems (IS) research by delivering useful artefacts and design theories to IS research (Hevner et al. 2004; Baskerville et al. 2018). DSR involves two primary activities: (1) the creation of new knowledge through the design of novel or innovative artefacts and (2) the analysis of the artefact's use and/or performance (Vaishnavi & Kuechler 2015).

This research broadly followed a six steps approach comprising (1) Problem identification and motivation, (2) Objectives of a solution, (3) Design and development, (4) The demonstration, (5) Evaluation, and (6) Communication, as in (Peffers et al. 2007) with some adaptations. Figure 4-4 shows the adaptation of the six-step approach. Once we established that there is a problem in the industry practice, the objectives of the solution were translated as meta-requirement (MR)s. Before designing the artefact, we scanned the literature to find if there are any existing DPs that could be leveraged in the development of the artefact as represented in the box 3a *Identify Generic DPs* in Figure 4-4. Our scan led to the Commons DPs as a starting point for the artefact design. However, while developing the artefact iteratively we found that the Commons DPs were too generic to be relevant for the IS practice. Hence the artefact development and DPs refinement were carried out in parallel in an iterative manner, i.e., IS development feeding to the refinement of DPs and the DPs driving the IS development features. We followed Agile

development which combines the development and demonstration phases (Conboy, Gleasure & Cullina 2015). These iterative development and demonstration steps are described in the box 3b, 3c and 4 in Figure 4-4. We carried out the development in fortnightly sprints that followed a demonstration to an expert panel. The evaluation of the IS artefact and reusability evaluation of the DPs were carried out in step 5. The communication of the artefact was achieved through academic publications and industry presentations as shown in step 6.

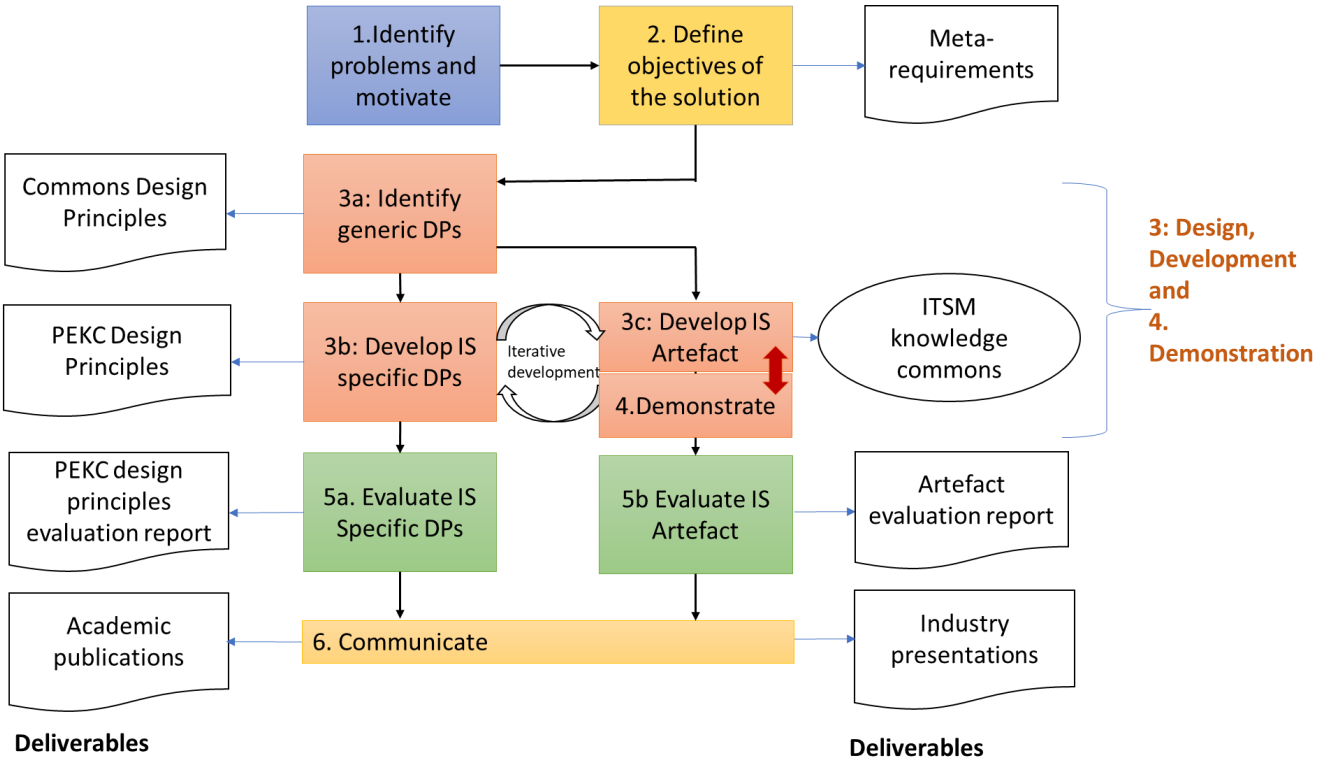

FIGURE 4-4 RESEARCH APPROACH ADAPTED FROM PEFFERS ET.AL (2007)

4.4.1 *IDENTIFY PROBLEMS AND MOTIVATE*

The motivation for the research came primarily from discussions with industry practitioners and academics teaching ITSM courses. The researchers engaged with practitioners through the IT Service Management Forum (ITSMF), which is a membership based global ITSM practitioner community. ITSMF International conducts a range of industry engagement activities, and these activities are managed nationally by

country specific ITSMF bodies. One of the researchers was active in ITSMF Australia and regularly attended face-to-face seminars in the state of Queensland in Australia. The researcher observed the problem of the changing landscape of process, technology, and skills within ITSM practice and the opportunity to develop a holistic knowledge platform. This opportunity was validated by conducting a Systematic Literature Review (SLR) to understand how comprehending the complexity of multiple process frameworks is addressed in the research landscape (reference removed for peer review). The industry inputs and literature review validated that the problem can be addressed through a holistic knowledge repository.

4.4.2 DEFINE OBJECTIVES OF THE SOLUTION THROUGH MRS

MRs describe the goals that are addressed in the class of problems (Walls, Widmeyer & El Sawy 1992; Walls, Widermeyer & El Sawy 2004; Kuechler & Vaishnavi 2012). MRs and DPs are essential components of a design theory (Walls, Widmeyer & El Sawy 1992; Gregor & Jones 2007). Goldkuhl (2004) proposed that a good design theory should be grounded in multiple dimensions. The dimensions are internal dimension, external theoretical dimension, and empirical dimension. Internal grounding implies the grounding of a design theory in its own background knowledge. The external theoretical grounding describes how the proposed design theory relates to other external theories. The external theoretical grounding is also concurred by Baskerville et al. (2018). The empirical grounding addresses how the design knowledge is practically relevant to the user community.

In this research, the internal grounding is demonstrated by deriving the MRs from the knowledge of the ITSM practitioners. The commons theory served as a basis for external theoretical grounding. The evaluation of the artefact and reusability evaluation of the DPs contributed to the empirical grounding of the design theory.

MRs were identified by understanding stakeholder needs (Lins et al. 2019) and synthesising literature from the relevant domain (Haj-Bolouri, Winman & Svensson 2020).The researcher initially discussed with the ITSMF Australia stakeholders the idea of developing a knowledge repository for ITSM knowledge. The initial reaction was positive. Some of the questions that were raised by the practitioners were "*how your repository is going to be different from the ITIL online books?," "how do you keep the repository up to date?" and "how can we trust the knowledge in the repository*?" These questions underpinned the objectives of the knowledge repository and formed the basis of meta-requirements.

Since Service-Symphony development was aimed to be a public domain to serve a large audience, we formed an expert panel to represent the community. The expert panel served as a mechanism for bouncing ideas and refining the requirements. These five panel members were experts with over twenty years of experience each, and voluntarily participated. The panel members guided the artefact development by suggesting improvements in the usability design, reviewing the knowledge, and mediating conflict resolution. The composition of the panel members is given in Table 4-1.

TABLE 4-1 EXPERT PANEL COMPOSITION

Member	Member profile
M1	A freelance senior consultant specialising in ITSM, DevOps and Governance. The consultant was recognised by the professional community for their contributions to the practice.
M2	Chief Information Officer of a government organisation with an interest in Governance, Service Management, and usability

M3	A senior consultant from the private sector. This member held a PhD in IT Service Management and had taken up a full-time teaching position.
M4, M5	Two members were nominated by the IT Service Management Forum (ITSMF), Australia.

The first MR directly addresses to relevance aspect of DSR. One of the primary objectives of DSR is to develop IS artifacts that are relevant to the user community (Hevner 2007; Wieringa 2010). We captured the "user stories" from different stakeholders' perspectives and consolidated these stories as a MR. A user story is a method of requirements elicitation in Agile development that captures the needs of different users (Dalpiaz & Brinkkemper 2018; Kannan et al. 2019; Amorim et al. 2021)

A user story is often written in the format "As a *[type of user],* I want *[some goal]* so that *[some reason]*." (Dalpiaz & Brinkkemper 2018; Kannan et al. 2019). Based on this format, we derived the following user stories:

"As an ITSM practitioner, I want to understand the current ITSM processes so that I can apply them at my workplace "

"As an ITSM practitioner, I want to understand the complementary processes so that I can expand my career options"

"As an ITSM student, I want to understand current ITSM practices that are relevant to my course and complete my academic assignment"

PEKC was aimed to hosting a wide range of process frameworks, tools, and skills with a diverse user base. It was a challenge to remain relevant to a critical mass of users in a fast-changing environment. This challenge was captured through the first meta-requirement.

The commons theory is proposed as a credible alternative to privatisation through participative governance and achieving desired outcomes

through collaboratively managing a common-pool resource. Ensuring that the outcome is fair and relevant to the stakeholders is one of the core principles of Ostrom's theory. is the commons theory refers this aspect as 'congruence' and the first MR is grounded to this principle.

MR1: Stakeholder Congruence: The PEKC instance design should be congruent to the needs of target stakeholder communities

Another MR was introduced through a literature review and internal reflection. It is important that PEKC stays relevant over an extended period to provide value to the user community. Mindel, Mathiassen and Rai (2018) introduced the concept of sustainability in knowledge platform design. Sustainability is the capacity of the knowledge commons to continually provide value to stakeholders (Mindel, Mathiassen & Rai 2018). The sustainability concept is supported by the constructs - of provision, appropriation, revitalization, and equitability (Mindel, Mathiassen & Rai 2018). The user stories reflect the intent of sustainability.

"As PEKC developers, we want Service-Symphony to sustainable at least for 5 years so that our research makes a tangible impact on the professional community"

"As ITSM practitioners we want Service-Symphony to be sustainable for at least for 5 years so that we have continuity in our knowledge gathering"

"As ITSM students we want Service-Symphony to be sustainable for at least for 5 years so that we can tap into the industry knowledge after we graduate"

One of the fundamental drivers of Ostrom's contribution is to provide a counter argument to Hardin's tragedy of commons that hypothesised that a common resource pool management is not sustainable. Ostrom showed that there are evidence of successful commons and they are sustainable through participative community arrangements. Hardin's theory

speculated that the resource would be depleted, not sustainable through over consumption. In contrast, Ostrom demonstrated that the participative management contributed to sustainability of the resources as community contributes to replenishing the depleted resources. The sustainability aspect of the design is captured in MR2.MR2: Artefact Sustainability: The PEKC instance designed to sustainable for the desired period

The trustworthiness of PEKC was one of the concerns flagged by the practitioners. Any information that is available online can be easily manipulated which raises the question of trustworthiness (Cheshire 2011; Pan & Chiou 2011). Kittur, Suh and Chi (2008, p. 477) ask a rhetorical question "*Can you ever trust a wiki*?" noting that peer editing of Wikipedia leads "*many to distrust it as a source of reliable information*". On the other hand, a study points out that one-third of higher education students used Wikipedia for academic purposes (Lim 2009). The study notes that the frequency of Wikipedia usage is higher than the University's library database. The dimensions viz., accuracy, stability, and validity can be used to assess the information's trustworthiness (Huang et al. 2016). In addition to the information content, the user observes various credibility cues to assess trustworthiness. The credibility cues can be the way the information is presented, the reputation of the author links to other references, and feedback from readers. The perceived importance of the credibility cues varies according to individual motivation and other factors (Machackova & Smahel 2018). The following user stories articulate the trustability requirements.

"As ITSM practitioners, we want the PEKC knowledge to be trustworthy, without any commercial biases, so that we can use the information without compromising our integrity"

"As ITSM students, we want to trust PEKC knowledge so that we can use the information in our academic assignments"

Trust is one of the key aspects of Ostrom's commons theory. The participative governance built on empowerment to manage the benefits, decentralized decision-making arrangements, authority to provide sanction to maintain order are based on trust. To support the design of a PEKC that is trustworthy, the following MR is introduced.

MR3: Community Trustability: The PEKC instance should be considered trustworthy by the target communities

The three MRs captured the objectives of the solution. The next section describes the design phase. The approach to developing MRs is visually represented in Figure 4-5

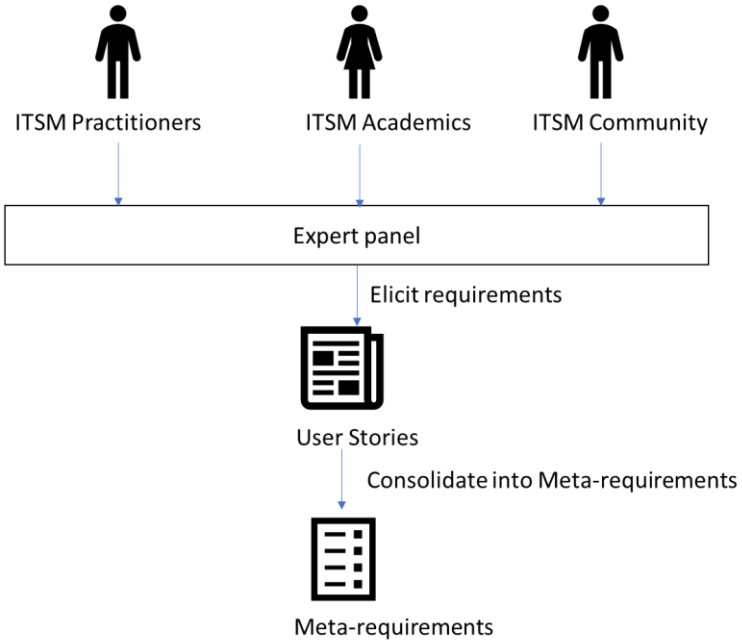

FIGURE 4-5 META-REQUIREMENTS DEVELOPMENT APPROACH

4.4.3 IDENTIFY GENERIC DPS

The commons theory proposed eight DPs to analyse commons ecosystems that are primarily intended to govern natural resources. While not all DPs are mandatory, at least some DPs are required to implement a successful, long-lived commons ecosystem (Dourado & Tabarrok 2015). Though we found common theory as a starting point, the commons DPs were generic and did not consider IS specific aspects. We iteratively

refined the knowledge commons DPs to suit IS while developing the IS artefact.

4.4.4 *Develop IS specific DPs*

To apply the DPs to PEKC, a three-step analytical approach was followed. In the first step, the differences between natural resources and knowledge were examined. The first step resulted in key attributes that are critical to analysing the DPs in the second step, in which each design principle was examined closely to consider whether it applied to PEKC. The third step was applying PEKC DPs to Service-Symphony. In this step, we evaluated whether a design principle is relevant for the specific PEKC and how the relevant principles could be applied. The three-step approach is presented in Figure 4-6.

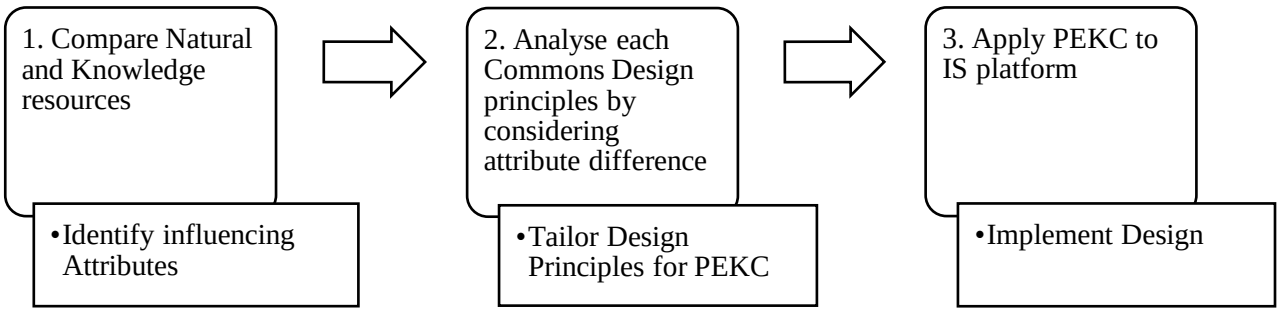

Figure 4-6 Derivation and application of PEKC DPs

The first step in the derivation process was to compare the characteristic attributes of natural resources and knowledge. Mindel, Mathiassen and Rai (2018) consider the attributes as theoretical constructs following the three-level theoretical abstraction model (Van de Ven 2007). The three levels of abstraction are concept, constructs, and observable variables/events. The theoretical constructs provide mid-level abstraction. Though many attributes can be compared between natural commons and knowledge commons, we identified four core attributes viz., creation, exclusion, subtractability, and revitalization. Each of the four attributes is discussed further below.

A fundamental difference is that a knowledge resource must be created as opposed to a natural resource that already exists (Frischmann, Madison & Strandburg 2014). While the "creation" attribute may be self-evident, knowledge creation had to be explicitly considered to analyse the DPs as it differentiates the design of knowledge commons from other types of commons.

Commons theory considered two key attributes namely exclusion and subtractability to classify the goods (Ostrom 1990; Hess & Ostrom 2007). The attribute exclusion refers to the difficulty in restricting people who use the goods. For example, there could be physical fencing to restrict the use of a common herding pasture. Goods, where individuals could be excluded from use, were considered private goods, as opposed to public goods which are available to all. If one person's use is subtracted from the available goods for others the good is said to be subtractable (Ostrom 1990; Hess & Ostrom 2007). Many natural commons like fisheries and forestry have subtractable resources as consumption depletes the resource.

The attributes exclusion and subtractability were relevant to PEKC as these attributes could be artificially imposed through the design. We noted that: (1) the PEKC could be designed for varying degrees of exclusion and subtractability; and (2) a single PEKC could have different combinations of exclusion and subtractability. For example, consider an online news platform. The headline news could be read by anyone without depleting the knowledge resource availability (no-exclusion – no-subtractability). The news platform could implement subscription-based access to access the premium content thereby excluding the non-subscribers and still not depleting the knowledge resources (exclusion – no-subtractability). The subtractability attribute is implemented through a quota system. For example, the news platform could limit the number of free articles accessed by any user. There are no exclusions in this scenario as anyone could access the content, but subtractability is

implemented by restricting the number of accessed articles (no-exclusion – subtractability). In this scenario, though the available articles are not depleted, from the consumption perspective there is a depletion of articles with every access. Finally, if we consider a scenario where the news platform targets students and offers free access to premium content that is limited by quota, the resultant model will fit into the exclusion-subtractability quadrant. Table 4-2 shows the different combinations of the exclusion and subtractability attributes in a single PEKC.

TABLE 4-2 APPLYING DIFFERENT COMBINATIONS OF SUBTRACTABILITY AND EXCLUSION IN PEKC (ADAPTED FROM (HESS AND OSTROM 2007))

	No Subtractability	**Subtractability through quota**
No exclusion	News headlines available for all readers	The number of free news articles is limited by quota for individual readers
Exclusion through access restriction	Premium news content is available through a subscription	Premium discounts are available for the selected user group (for example, students), limited by quota

The attribute "revitalization" is used to describe the difference between new active users versus disengaged users (Mindel, Mathiassen & Rai 2018). The revitalization attribute is aligned with the "comedy of commons" argument by Rose (1986). The "comedy of the commons" notes that unlike the "tragedy of commons," which was concerned only about the depletion by overuse, the public properties will thrive only if there is patronage.

Table 4-3 summarises the differences between Natural Commons and PEKC.

TABLE 4-3 DIFFERENCES BETWEEN NATURAL COMMONS AND PLATFORM ENABLED KNOWLEDGE COMMONS FOR FOUR KEY ATTRIBUTES

Attribute	Natural Commons	Platform Enabled Knowledge Commons
Creation (Frischmann, Madison & Strandburg 2014)	Natural resources (for example, rivers, forests) are already present in the universe	Knowledge resources are created by humans
Subtractability (Ostrom 1990; Hess & Ostrom 2007)	The units consumed will reduce the availability of resources in the common pool	Varying levels of subtractability can be designed in PEKC
Exclusion (Ostrom 1990; Hess & Ostrom 2007)	Individuals can be excluded from using a resource.	Varying levels of exclusions can be designed in PEKC
Revitalization (Mindel, Mathiassen & Rai 2018)	Natural resources need to be replenished as they deplete	Though knowledge does not decay, the value of knowledge can change with time and needs to be maintained. Attracting more users is essential for the sustainability of PEKC.

In the second step of the derivation process, each natural commons design principle (Ostrom 1990) was analysed considering the differences in attributes. Since the attributes of creation and revitalization are not present in natural commons, the knowledge commons DPs do not address these attributes. To support creation and revitalization we introduce two additional DPs:

PEKC_DP9: Improve Visibility of the knowledge platform within the target community

The visibility of the PEKC is the first step in attracting participants to visit, consume and contribute to the knowledge. In an online platform, consideration should be given in the technical design, information architecture and promotion to provide visibility of the PEKC to the target community. Increasing visibility is one of the primary principles to support MR2:Artefact Sustainability.

PEKC_DP10: Provide incentives to motivate participants to create and consume knowledge

The second DP introduced is to provide incentives to the participants to consume and contribute to PEKC. In natural commons, since the objective is to reduce the free-riders only the penalties were considered. In PEKC both penalties and incentives needed to be considered. It is a challenge for IS designers, as the incentives often are non-financial and the IS design need to explicitly consider and support providing incentives. Providing incentives motivates the participants to contribute and hence contributes to MR2: Artefact Sustainability.

Table 4-4 shows a summary of the PEKC DPs and their alignment to influencing attributes and MRs.

TABLE 4-4 DERIVATION OF PEKC DPS

PEKC DPs	**Corresponding Natural Commons (NC) DPs (Ostrom 1990)**	**Influencing attributes**	**Corresponding MRs**
PEKC_DP1: Define broad knowledge boundaries	NC_DP1: Clearly defined boundaries	Creation,	MR1: Stakeholder Congruence
PEKC_DP2: Control participant access to the	NC_DP2: Congruence that allows the members to share the benefits	Exclusion, Subtraction	MR1: Stakeholder Congruence MR3: Community ,Trustablity

platform to enable tiered benefits provision	and costs proportionally		
PEKC_DP3: Establish mechanisms for stakeholders to collaborate	NC_DP3: Collective-choice arrangements that enable members to establish local rules	Creation, Exclusion, Subtraction	MR1: Stakeholder Congruence, MR3: Community Trustablity
PEKC_DP4: Analyze the performance of the platform and visitor behavior	NC_DP4: Monitoring of community behaviors	Creation, Exclusion, Revitalization	MR1: Stakeholder Congruence, MR3: Community Trustablity
PEKC_DP5: Apply penalties to deter offenders	NC_DP5: Graduated sanctions	Exclusion	MR2: Artefact Sustainability MR3: Community Trustablity
PEKC_DP6: Resolve conflicts between stakeholders	NC_DP6: Community members will have conflict resolution mechanisms	Exclusion	MR3: Community Trustablity
PEKC_DP7: Provide guidelines for local content customization, if applicable	NC_DP7: The community rules are recognized by government authorities	Creation	MR1: Stakeholder Congruence,

PEKC_DP8: Implement knowledge structure hierarchy and management, if applicable.	NC_DP8: Nested enterprises	Creation, Subtraction, Exclusion, Revitalization	MR1: Stakeholder Congruence, MR2: Artefact Sustainability, MR3: Community Trustablity
PEKC_DP9: Improve Visibility of the knowledge platform within the target community	New	Creation, Revitalization	MR2: Artefact Sustainability,
PEKC_DP10: Provide incentives to motivate participants to create and consume knowledge	New	Creation, Revitalization	MR2: Artefact Sustainability

The following section shows the details of the derivation of the PEKC DPs.

DP1. Clearly defined boundaries: DP1 proposes that the boundaries of the natural commons must be well-defined. Ostrom (1990) cites the case of the Torbel Community in Switzerland, a village of about six hundred people. Written legal documents referring to the Torbel Community, dating back to 1224, define clear boundaries. The documents mention the type of properties such as the alpine grazing meadows, forests, wastelands, and irrigation systems. Besides, they also clearly articulate the paths and roads that connect the properties.

In knowledge commons, there are no naturally defined boundaries that regulate user access. Frischmann, Madison and Strandburg (2014) point out that the boundaries for knowledge commons are built rather than found. Since knowledge resources evolve, the boundaries also will

correspondingly expand or contract. While we acknowledge that boundaries are important in PEKC, they need not be as clearly defined as in the case of natural commons. The boundaries can be broad and flexible. Hence, we tailored the design principle to "*Define broad knowledge boundaries* ." This design principle is influenced by the attributes "exclusion" and "creation." One of primary of objectives defining the knowledge boundaries is to align the knowledge with stakeholder expectations. Hence DP1 is aligned with MR1: Stakeholder Congruence.

DP2. Congruence that allows the members to share the benefits and costs proportionally: DP2 addresses the distribution of benefits from appropriation rules. Ostrom (1990) uses the term "appropriation" to describe the process of withdrawing resource units from a resource system. For example, "appropriator" can be a generic term to describe communities such as herders, fishers, irrigators, and commuters. The design principle is intended to impose a fair sharing of benefits. Appropriation is applicable in some types of PEKC which can impose appropriation through mechanisms like tiered membership levels, subscriptions, and geographical access restrictions. To suit PEKC, we termed this design principle as "*Control participant access to the platform to enable tiered benefits provision*." This design principle is influenced by the attributes "exclusion" and "subtraction." The underlying MRs to carry out effective benefits sharing are MR1: Stakeholder Congruence and MR3: Community Trustability

DP3. Collective-choice arrangements that enable members to establish local rules: DP3 deals with collective-choice arrangements. Collective choice refers to empowering individuals in an operating environment to participate in modifying the operating rules. The fishing villages of the eastern coast of Canada were cited by Ostrom (1990) as examples. These fishers had developed their own rules. These local rules

define who can enter the fishery and local fishing grounds were divided among fishers using different technologies

In a PEKC, the collective choice is applicable in scenarios like collaborative development, making decisions about the inclusion of knowledge articles, and retirement of knowledge. The design principle is termed "*Establish mechanisms for stakeholders to collaborate*" and is influenced by the attributes "creation," "exclusion" and "subtraction.". The stakeholder collaboration is one of the primary principles of PEKC design and hence it contributes to all the MRs.

DP4. Monitoring of community behaviours: Monitoring the health and performance of the ecosystem and user behaviour are addressed as part of the DP4 principle. Ostrom (1990) advocates monitoring for overseeing the community member's performance and compliance with rules. The fishing agreements in Alanya, Turkey were cited as an example. The annual fishing spot allocation was done and agreed upon by the fishing community. On the allocated day, the fishers would turn up to his or her allocated fishing spot. The community monitoring ensured that the fishers did not turn up on other days or expand their allocated area. Monitoring is important to PEKC to ensure knowledge value is retained and trusted by the community. Though the intent is the same, the implementation of monitoring between natural commons and PEKC is different. In natural commons, typically member behaviours are monitored through physical observations and manual interventions. In PEKC, the performance can be monitored through data analytics reports. Hence, this design principle is called "*Analyse the performance of the platform and visitor behaviour*." This principle is influenced by the attributes "exclusion," "subtraction" and "revitalization." As monitoring helps to take actions to align the knowledge with the community expectations, DP4 contributes to MR1:Stakeholder Congruence. Also, monitoring is related to MR3:Community Trustablity.

DP5. Graduated sanctions to regulate member violations: This principle suggests graduated sanctions for users who violate operational rules depending on the seriousness and context of the offence. Ostrom (1990) observes the sanctions are comparatively low in comparison to a monetary loss of the offence – Spanish farms, Philippine irrigation systems, and Japanese mountain commons are cited as examples.

PEKC needs to implement graduated sanctions to ensure that the repository is reliable. Safner (2016) suggests that in PEKC, communal shaming, temporary bans, and permanent bans can be considered as graduated sanctions. We call this principle "*Apply penalties to deter offenders*" which is primarily influenced by the attribute "exclusion" as the bans imply that the participants are excluded from accessing the PEKC temporarily or permanently. DP5 contributes to MR2: Artefact Sustainability and MR3: Community Trustability. Applying penalties through temporary or permanent bans ensures that cyber attacks and inappropriate member behaviours are curbed immediately. Without these measures the PEKC cannot survive in the online environment. Even one cyber-attack can erode the trust of the community that was built over a many years.

DP6. Conflict-resolution mechanisms that are fair: The design principle DP6-Conflict Resolution is associated with DP5. DP6 observes that effective Commons have access to low cost, local conflict resolution mechanisms. In governing Commons, Ostrom (1990) observes that simple rules for irrigation canal clean-up roster can be interpreted quite differently by different individuals and argues the need for local conflict resolution mechanisms. The intent of implementing a conflict resolution process is the same for natural resources knowledge commons and PEKC. The principle is called "*Resolve conflicts between stakeholders*" and is influenced by the attributes "exclusion" and "creation." The conflicts could arise while creating content as each contributor might have their agenda to communicate certain messages to the public. PEKC design

features can consider inherent conflict resolution mechanisms like blocking multiple changes by a single author within a brief period, or temporarily blocking the non-compliant author. The blocking of participants with undesired behaviours is underpinned by the "exclusion" attribute. DP6 contributes to MR3: Community Trustability as conflict resolution enhances trustability.

DP7. Recognition of rights of group members to self-organize internally: The rights of local communities to form local rules are addressed in the DP7 principle. Ostrom (1990) cites the example that in fisheries, local fishers devise extensive rules defining who can use a fishing ground and what kind of equipment can be used. In PEKC, we interpret this design principle as the degree of flexibility provided to groups that enable local customization of content. This is an optional design principle. A PEKC may impose strict standards across all the knowledge articles or may choose to allow some degree of flexibility as long the created knowledge adheres to the overall objective of the PEKC. This design principle is called "*Provide guidelines for local content customization*" which is underpinned by the "creation" attribute. The consistency between knowledge contents contributes to MR1: Stakeholder Congruence.

DP8. Nested Enterprises that allow a structural hierarchy of groups: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises. Such a nested, hierarchical structure is an optional design principle for PEKC. One of the examples of a nested enterprise structure is the implementation of a PEKC within a multi-national organization that shares a common knowledge repository. There could be local creation and governance of knowledge by various functional units with overarching central governance. This design principle is called "Implement *knowledge structure hierarchy and management, if applicable.*," which is supported by all the attributes. As the knowledge

structure hierarchy is self-contained instance of the parent, DP8 contributes to all the three MRs.

DP 9 Improve Visibility of the knowledge platform within the target community: As the knowledge commons is part of the internet ecosystem, it needs to be visible to the target community. The usefulness of the internet rests to a significant degree on search engines and knowledge commons need to consider the design of "findability" (Kallinikos, Aaltonen & Marton 2013). Search Engine Optimization (SEO) is considered an essential digital marketing technique (Bhandari & Bansal 2018; Chan, Krishnamurthy & Desjardins 2020). Another channel of improving visibility is using social media (Felix, Rauschnabel & Hinsch 2017; Tafesse & Wien 2018). We argue that improving visibility is a critical aspect of the knowledge commons and thus warrants a design principle. This DP is underpinned by the attribute "creation" and "re-vitalization." The environment demands that for survival and growth the PEKC needs to be visible and hence DP9 contributes to MR2: Artefact Sustainability.

DP 10 Provide incentives to motivate participants to create and consume knowledge: In contrast to natural commons, the survival of knowledge commons depends upon the continued patronage of the users (Mindel, Mathiassen & Rai 2018). Ostrom's design principle explicitly addressed sanctions but did not include "incentives" to encourage the use of the commons. The omission could be due to the implicit assumption that natural commons will be consumed without the need to incentivize the participants. The incentives can be both financial and non-financial. The success of Wikipedia is attributed to the contribution of voluntary authors. Researchers have analysed various aspects of Wikipedia's motivational factors (Salehan, Kim & Kim 2017; Wang et al. 2018). Salehan, Kim and Kim (2017) identify these motivations as vertical social, horizontal social, hedonic, and utilitarian. A different classification of motivational factors for virtual collaboration viz., intrinsic, extrinsic, and

community, is proposed by Wang et al. (2018). Specific attributes of the knowledge platforms influence motivations to contribute to knowledge (Park & Park 2016; Pee 2018). Hence, a design principle, "*provide incentives*" is introduced which is underpinned by the creation and revitalization attributes. Providing incentives contribute to MR1: Artefact Sustainability as the incentives ensure that the stakeholders maintain the interest in maintaining the knowledge within the PEKC instance,

4.5 APPLICATION OF PEKC DPS TO SERVICE-SYMPHONY

This section discusses how the PEKC DPs were applied to Service-Symphony. Figure 4-7 shows the mapping between the MRs, DPs and design features. Not all DPs are applicable to the PEKC instance we developed. Some aspects of DP6, DP9 and DP10 were implemented outside the PEKC instance, Service-Symphony.

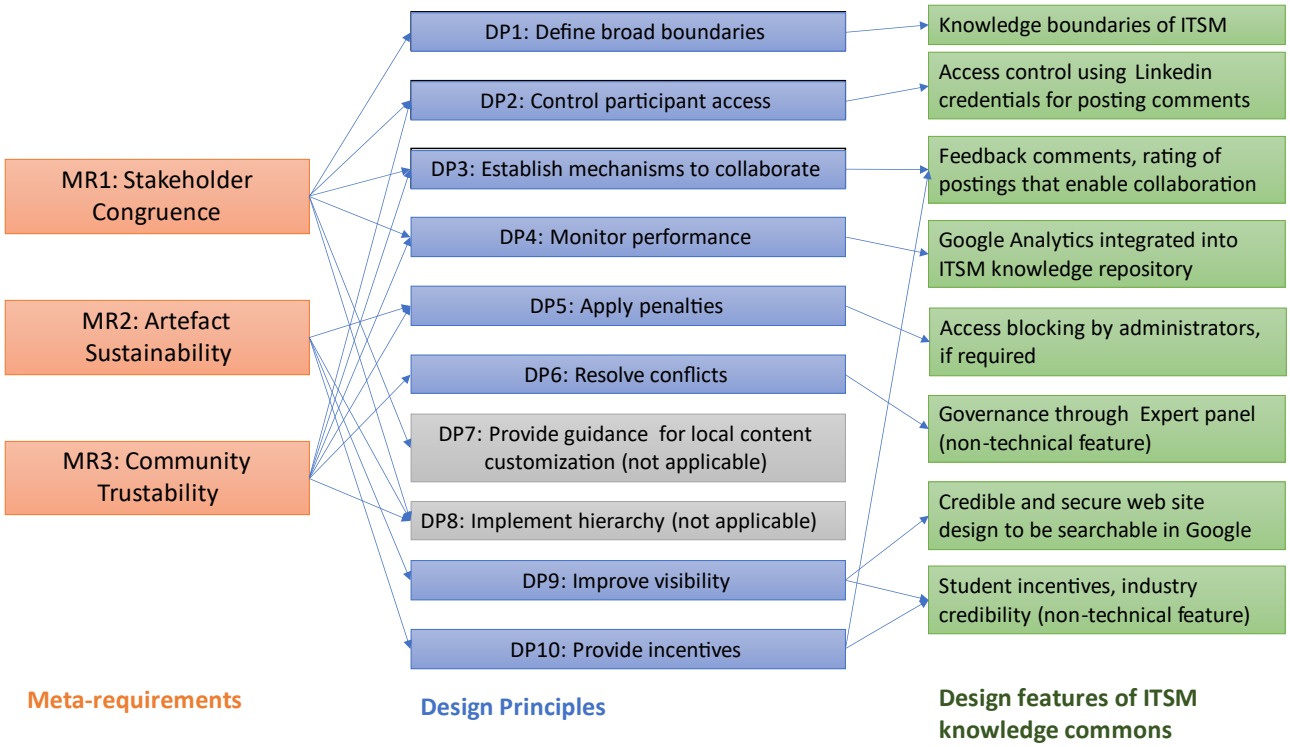

FIGURE 4-7 MAPPING BETWEEN META-REQUIREMENTS, PEKC DPS AND DESIGN FEATURES

PEKC_DP1_ Define broad knowledge boundaries : Service-Symphony was designed with a broad boundary to include knowledge of

process frameworks, tools, and skills that are applicable in the ITSM domain. The broad boundary encompasses governance, project management, quality, ITSM, continual improvement, and any other complementary domains. Within these domains, there are multiple frameworks. There are overlaps between the domains. The repository currently hosts twelve process frameworks and thirty-five practices.

The landing page of Service-Symphony is shown in Figure 4-8 demonstrating the broad knowledge boundary encompassing processes and tools. The knowledge articles of the process areas cross-reference the skills.

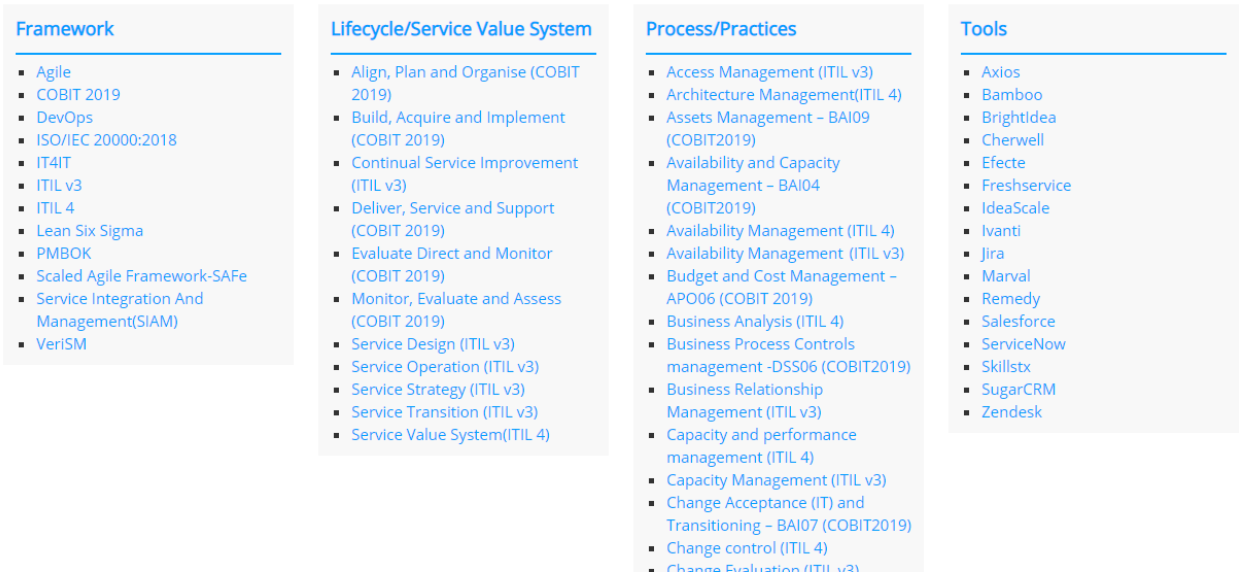

FIGURE 4-8 IMPLEMENTATION OF BROAD KNOWLEDGE BOUNDARIES IN SERVICE-SYMPHONY

PEKC_DP2_ Control participant access to the platform to enable tiered benefits provision: The participant access was controlled through three levels of access control. Any participant, without the need to register, can browse and read all the articles without any restrictions. To post comments the participants could log in through LinkedIn credentials, which was our way of ensuring only members of the professional community provide feedback to the knowledge articles and rate the tools listed in Service-Symphony. In addition, the comments

were moderated by the administrator before they were visible to the public. The third level is the administrator access which was managed by one of the researchers.

PEKC_DP3_ Establish mechanisms for stakeholders to collaborate: This design principle was implemented, outside the IS knowledge platform technical architecture. Whenever there was a major knowledge update or system feature addition, feedback was solicited from the expert panel. The expert panel provided inputs to prioritize the platform features and knowledge updates. Within PEKC the participants could post their views about the articles and rate their peer's feedback. In the given example in Figure 4-9, the user has rated the article 5 out of 5 and asked an open question.

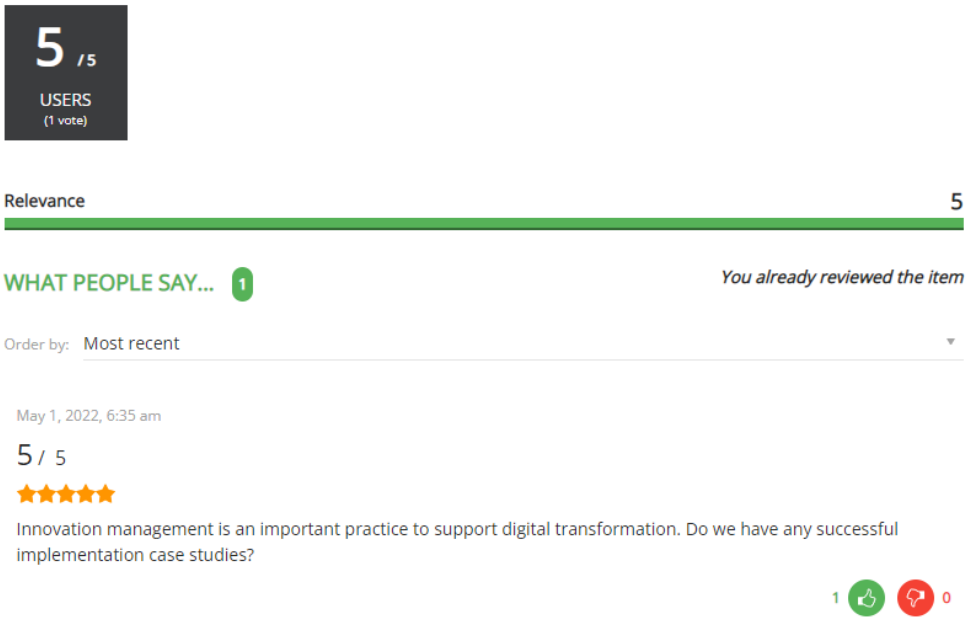

FIGURE 4-9 ESTABLISHING MECHANISMS FOR PARTICIPANT COLLABORATION

PEKC_DP4_ Analyse the performance of the platform and visitor behaviour: This design principle was implemented within the IS knowledge platform. To monitor the knowledge repository performance, a widely adopted web analytics service that provides statistics and

analytical tools for search engine optimization, Google Analytics, was integrated into the repository. Figure 4-10 shows an overview of the analytics dashboard. The data indicates that there has been stead raise of the user the trend from April 2019 to September 2022 with around 137,000 new users. Around 28.5% (54,774) visitors access Service-Symphony more than once suggesting that they are interested in the knowledge presented by Service-Symphony. Further behaviour analysis can be performed through the analytics data.

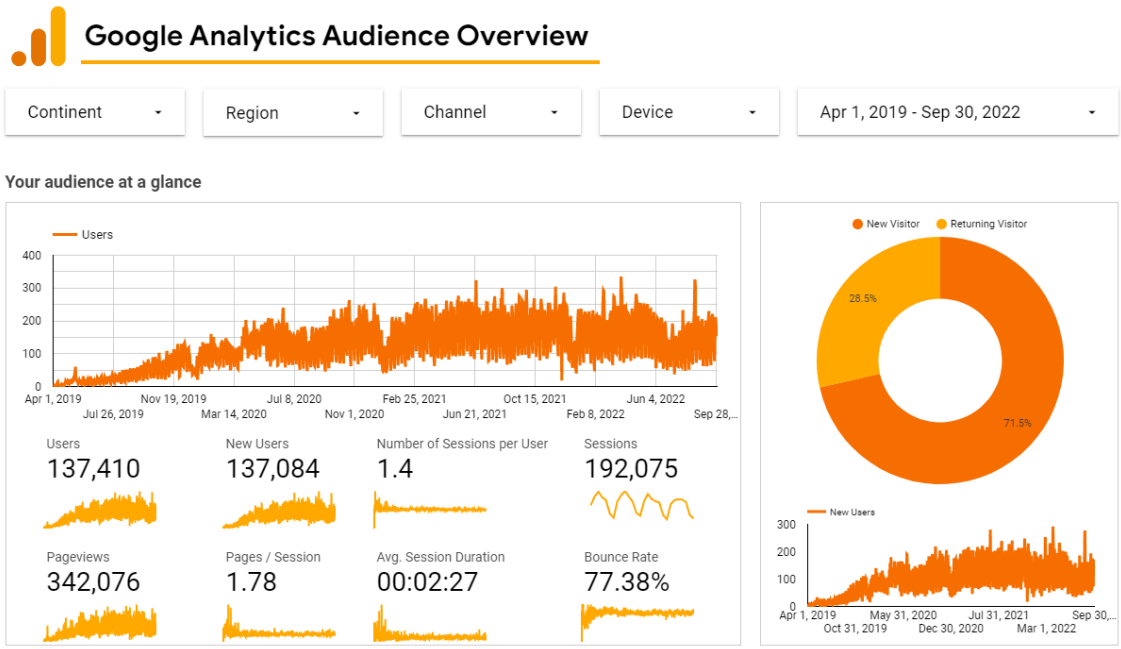

FIGURE 4-10 MONITORING PERFORMANCE OF ITSM PEKC THROUGH WEB-ANALYTICS – APRIL 2019 TO SEPTEMBER 2022

PEKC_DP5_ Apply penalties to deter offenders: The primary penalizing mechanism of ITSM PEKC was blocking the user for a specific period and blocking permanently repeat offenders. This action would be performed by the administrator.

PEKC_DP6_ Resolve conflicts between stakeholders: The conflict management process was executed externally through the expert panel.

For example, there was a discussion of whether to include a process framework that is not a mainstream standard. One of the panel members advised rejecting the framework stating, "*I would be really careful about the use of additional frameworks. I note that frameworks under consideration are not amongst anything I have ever heard of before*." In the future, some aspects of conflict management could be incorporated within the platform itself. For example, Wikipedia's talk feature is one of the ways of managing conflicts within the author community (Safner 2016).

PEKC_DP7 and PEKC_DP8: These DPs were not relevant to the PEKC that is centralised. The implementation of hierarchy and local content customization are relevant to the PEKC that are de-centralised governance structure.

PEKC_DP9_ Improve Visibility of the knowledge platform within the target community: Providing visibility to the knowledge platform is critical to the success of the research. Visibility is provided through promotions during industry forums and on social media platforms. The knowledge portal was made a secure site to improve searchability within Google and improve trust. The platform did not include any advertisements. As a result, Service-Symphony was visible to the stakeholders when they were searching online. Figure 4-11 shows that 86% of the user base is acquired through organic search indicating that the Service-Symphony design is consistent with DP9.

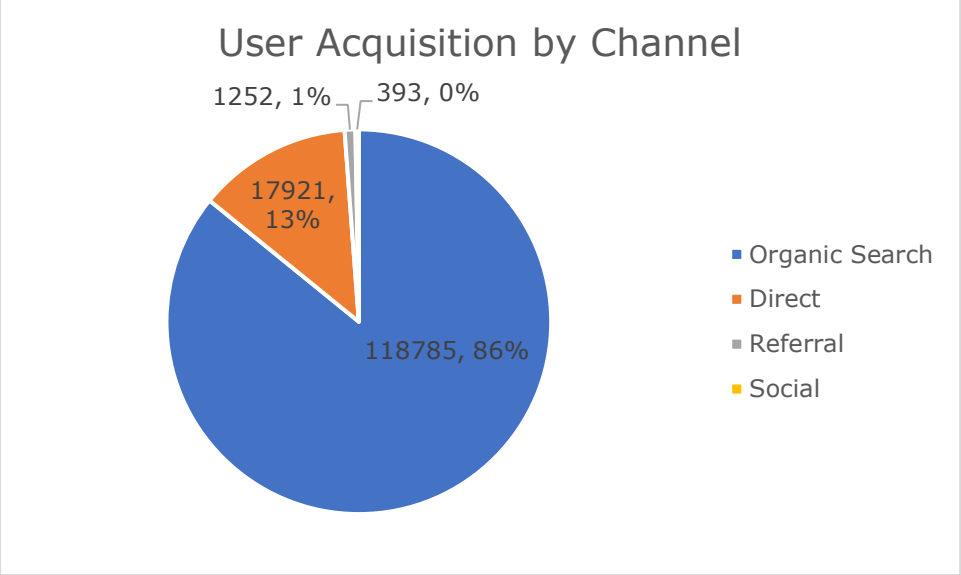

FIGURE 4-11 SERVICE-SYMPHONY USER ACQUISITION BY CHANNEL

PEKC_DP10_ Provide incentives to motivate participants to create and consume knowledge: As the platform is public-facing, providing incentives is a challenge. The research encouraged participation by posting topical articles on LinkedIn. The IS platform was integrated with LinkedIn to provide professional credibility and motivation to contribute to the knowledge. The features such as voting and "like" buttons serve as incentives to actively engage with the platform. To encourage the student community participation, the ITSM knowledge commons was integrated into the ITSM academic curricula of an Australian University <<Reference Removed for Review>>. The students were encouraged to refer to the ITSM knowledge commons as part of a research activity that was tied to an assessment. Hence, there were academic incentives for students to participate.

4.6 EVALUATION OF IS ARTEFACT

Rigorous evaluation of artefacts is an important aspect of DSR (Peffers et al. 2012; Venable, Pries-Heje & Baskerville 2016). Evaluation of artefacts can be performed at various stages of product development. The evaluation can be classified as *ex-ante* vs *ex-post* evaluations (Venable, Pries-Heje & Baskerville 2016). During the formative stages of artefact

development, *ex-ante* evaluation can be performed which is a predictive evaluation. *Ex post* evaluation is an assessment of the value of the implemented system. To ensure that the repository is aligned with the practitioner community's expectations, an expert panel was formed comprising four industry practitioners and one academic expert. During ITSM knowledge repository development, *ex-ante* evaluation was performed by receiving feedback from the expert panel. The product development was carried out in fortnightly sprints. After every sprint feedback was sought from the expert panel. The panel commented on the features, quality of the knowledge, and usability. The ex-post evaluation of the instantiated artefact consisted of receiving feedback from practitioners, undergraduate students, and post-graduate students. Figure 4-12 shows the evaluation strategy of Service-Symphony.

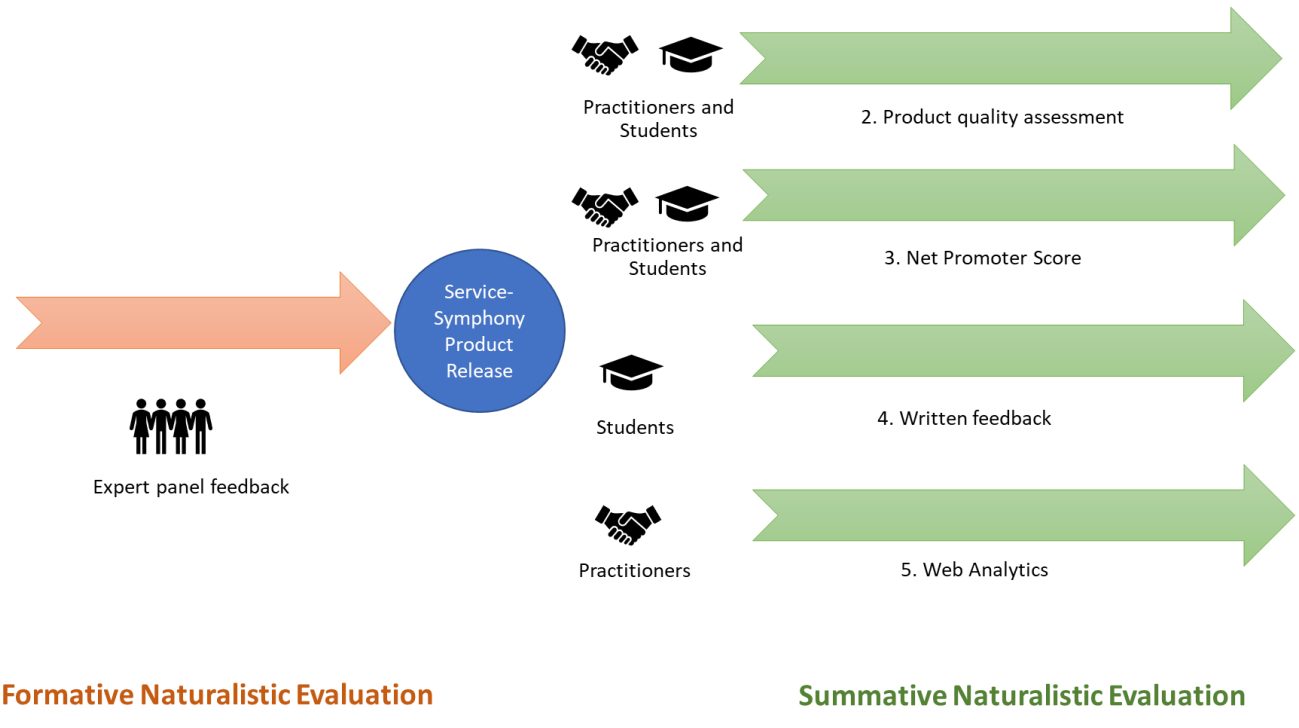

FIGURE 4-12 EVALUATION STRATEGY OF SERVICE-SYMPHONY

The practitioner feedback was received after demonstrating the ITSM knowledge repository at an ITSMF state seminar in Brisbane, Australia. A paper-based survey was administered. We received 26 responses from the participants. The participants indicated that the repository was useful

and suggested improvement opportunities to include multi-lingual support and more case studies. In the student evaluation, 46 postgraduate students and 33 undergraduate students participated who were studying an ITSM course at an Australian University. The methodological triangulation approaches (Jack & Raturi 2006; Bekhet & Zauszniewski 2012) was followed to evaluate the student perception of the repository. The methodological triangulation used diverse measurements including the Net Promoter Score (NPS), a product quality survey, and free format written feedback about the usefulness of the repository. The three measurements showed a consistent theme, namely that the repository was useful to students. The students suggested improvement opportunities including engaging interface design and more case studies on the implementation of the frameworks <<Reference Removed for Review>>.

In addition to focussed evaluation, visitor trends are being continually monitored. The visitor trends provide insight about geographic regions, the pages visited and other useful metrics to improve the ITSM knowledge portal. Google Analytics of the knowledge portal indicates that there has been a steady rise in visitors accessing the portal. Reusability evaluation of the DPs

DPs guide the development of multiple instances of IT artefacts that belong to the same class (Kruse, Seidel & Purao 2016; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). If reusability is not evaluated by practitioners, there is risk that the DPs are not useful in the practice (Cronholm & Göbel 2018; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). To mitigate this risk, Iivari, Rotvit Perlt Hansen and Haj-Bolouri (2021) propose a revaluation framework comprising the following five criteria: (1) accessibility, (2) importance, (3) novelty and insightfulness, (4) actability and guidance, and (5) effectiveness.

The key focus of this research is the development and evaluation of the DPs. Iivari, Rotvit Perlt Hansen and Haj-Bolouri (2021) emphasise that

the target audience of the DPs should be clearly defined. Our target audience of the DPs are IS Solution Architects. Solution Architects are responsible for the design and communication of the design and development of integrated solutions that meet current and future business needs (SFIA 2021).

This research employed the focus group (FG) method to conduct the DPs evaluation. The FG technique is suitable for research that aims to understand how people feel and think about an idea (Henriques & O'Neill 2021). FG is one of the qualitative research methods employed in DSR (Gibson & Arnott 2007; Hevner & Chatterjee 2010; Tremblay, Hevner & Berndt 2010). Depending upon the goal of the research, the FG can be either *exploratory* or *confirmatory* (Hevner & Chatterjee 2010). The exploratory FG is to be used when the design artefact is to refine or improve the design. The confirmatory FG is to be employed when the design artefact's utility is to be confirmed. In our research case, we consider the FG as confirmatory as the primary goal is to confirm the reusability of the DPs in practice. The activities of the FG are: (1) problem definition, (2) identification of the participants, (3) moderator discussion guide, (4) conducting the FG and (5) analysis and interpretation (Stewart & Shamdasani 2014). We describe the key activities of problem identification, participant identification and results analysis in the following sections.

The objective of FG is to perform a confirmatory evaluation of the PEKC DPs based on the five criteria of the reusability evaluation framework (Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). For the FG, we expanded the criteria into descriptive questions as described in Table 4-5

TABLE 4-5 FOCUS GROUP QUESTIONS BASED ON REUSABILITY CRITERIA (IIVARI, ROTVIT PERLT HANSEN & HAJ-BOLOURI 2021)

DPs reusability criteria (Iivari, Rotvit Perlt	Focus Group questions

Hansen & Haj-Bolouri 2021)	
Accessibility	Can you understand and comprehend the PEKC DPs?
Importance	Do the DPs address important real-world problems?
Novelty and insightfulness	Did you get any new insights from the DPs?
Actability and guidance	Can the DPs be realistically applied in practice?
Effectiveness	Can the knowledge repositories that are created using the DPs create business value?

The target audience of the DPs is solution architects. The solution architects are responsible for developing and communicating solution architecture (SFIA 2021). The choice of architects to evaluate the DPs was guided by two considerations: (1) Architects are familiar with IS design as they are responsible for designing optimal IS solutions for the business problem. (2) Architects understand the importance of reusability and know how to design and evaluate reusable DPs.

The size of the *traditional FG* is typically 10-12 participants with a meeting duration of two hours (Hevner & Chatterjee 2010). The traditional FG is suitable for discussing exploratory questions. As the research objective is confirmatory, we opted for *mini-FG*. A mini-FG typically has 6-8 participants (Hevner & Chatterjee 2010). The architects were from an organization that employs around 7500 people and is where the primary researcher is employed. There were six architects in the practice, and all were invited to the FG. One architect declined the invitation due to work priorities resulting in the FG size of five.

All five participants had more than fifteen years of industry experience each. Among the five architects, four architects had TOGAF 9.2 certification, which is a standard for IS Architecture. The IS Architects were considered as external evaluators as they were not involved in the research project (Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). Table 4-6 shows the participant profile. There were two FG meetings held. In the first meeting, three architects participated with the remaining two architects participating in the second meeting.

TABLE 4-6 FOCUS GROUP PARTICIPANT PROFILE

Participant ID	Years of IT Experience	Title	TOGAF Certification
P1	15 years	Manager Architecture	Yes
P2	16 years	Principal Applications Architect	Yes
P3	18 years	Principal ICT Architect	Yes
P4	23 years	Principal ICT Architect	No
P5	27 years	Manager ICT Solutions	Yes

After the presentation and discussion, the participants were asked to evaluate and discuss the questions identified in Table 4-5. It was clarified that the questionnaire was not a quantitative survey, but used only to facilitate individual reflection that preceded the team discussion. An online anonymous questionnaire was created to facilitate individual reflection and collective sharing of the results as shown in Figure 4-13.

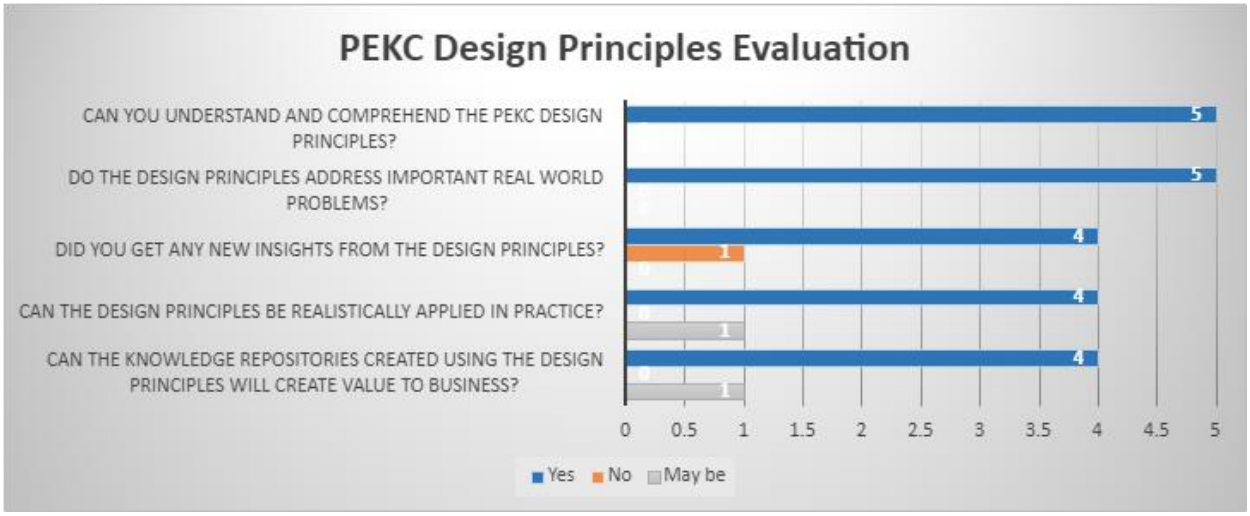

FIGURE 4-13 SUMMARY OF FOCUS GROUP RESULTS

All the participants agreed that the DPs are easy to understand and address an important real-world problem. All agreed that they got new insights from the DPs, except for one participant. The architect who disagreed had a specific solution in mind that was implemented in their previous organization, which was similar to the PEKC instantiation knowledge platform. It was clarified that the focus is on DPs, not the instantiated artefact. The remaining participants agreed that the DPs were "novel and insightful." They mentioned that they were not familiar with knowledge commons and the entire concept would be quite useful in designing knowledge systems in the organisational context. The architects acknowledged that their solution design would be primarily technology-centric, and the DPs provided a way to consider people/community interactions. They also agreed that the additional DPs on providing incentives, managing visibility and trust were important considerations that were sometimes overlooked.

For the question on DPs applicable to practice, the discussions were around the ability to tailor the DPs. The researcher explained that the DPs are meant to be tailored and not all DPs are mandatory. A participant said while they appreciated that tailorability aspect, they were not clear how a new DP could be added. The participant proposed that governance criteria

on how the DPs can be tailored should be addressed. The researcher agreed with that feedback.

Another practitioner was not sure whether the DPs could be applied in all scenarios in practice. The researcher probed whether the feedback concerned the knowledge commons or the DPs. The participant said he was referring to the DPs, not the knowledge commons concept. The participant was referring to a specific application where certain aspects of knowledge commons should not be shared due to confidentiality reasons. The participant argued that the confidential asset could be part of the larger knowledge commons, but only that area should be governed separately. They noted that the DPs do not cover this specific application of governing confidential data. This argument was refuted by another participant who noted that the DPs were applicable to most typical scenarios and could be tailored to suit any scenario.

Though all the participants have agreed to question-5 in the online questionnaire, during discussion one participant was not sure whether the question is relevant as the business value would depend upon the type of instances they are creating. The researcher agreed with the position that it is difficult to estimate the business value without describing the context of the instance.

4.7 DISCUSSION

We embarked on a research to develop DPs and apply them to the instantiated artefact, Service-Symphony that provides value to ITSM students and practitioners. The DPs address the solution class, PEKC. Various social media platforms, Wikipedia, organisational knowledge repositories, professional networking platforms, organisational social media are examples of PEKC. These diverse applications of PEKC provide value to stakeholders on different scales, ranging from individual to global benefits like improving human health and mitigating pandemics (Reichman, Uhlir & Dedeurwaerdere 2015).

Initially, we attempted to apply the extant knowledge commons DPs to develop Service-Symphony. This attempt identified the limitations of knowledge commons DPs and led us to develop a separate set of DPs that are accessible, relevant, and reusable by IS target audience. The PEKC DPs are novel and insightful because they guide designers to consider the larger social-technical environment instead of limiting their focus only to the technical environment. We realised deriving IS specific DPs from economic theory is not a straightforward process. The influencing attributes impact multiple DPs and the relationship is complex. Though many attributes can be compared between natural commons and knowledge commons, we identified only four core attributes viz., creation, exclusion, subtractability, and revitalization. There are also inter-relationships between DPs. For example, applying penalties, incentives and conflict management are closely related. We acknowledged this complexity and presented a mapping table that reflects the one-to-many relationships of these parameters. While presenting the DPs to the practitioners, we emphasized that the DPs are to be considered as a guidelines and not as a stringent product specification.

The evaluation of the DPs by the architects validated that the DPs are accessible and relevant to the practitioners. The architects found the DPs to be novel and insightful as it allowed them to think beyond the technical aspects of the instantiated artefact. The DPs also challenged them to consider design features to improve trust, providing incentives and apply penalties; the "soft aspects" that are normally not considered during a solution design.

The application of DPs to the instantiated artefact enabled us to appreciate whether the DPs are pragmatic. The instantiation helped us to clearly articulate the intended interpretation of the DPs. The instantiation was an important aspect of getting the buy-in from the practitioners. We recommend that when presenting DPs to practitioners, the researchers provide instantiated examples of how the DPs are applied.

The decision to conduct an FG interview was rewarding. Before engaging the practitioners, the research team was focused on academic rigour. As part of FG preparation, the researchers were motivated to revisit the DPs as to whether they are articulated to suit the practitioners. One of the methods that differs from conventional FG, in that we used an online, live survey. This deviation proved to be effective, as the meeting was conducted in an online collaborative environment due to Covid restrictions as opposed to face-to-face meetings.

4.7.1 CONTRIBUTIONS TO THEORY

The seminal paper (Gregor & Hevner 2013a) proposed three levels of knowledge contribution in DSR research. They proposed that the DSR contributions can be at Level1: Situated instantiations of artefacts Level2: Nascent design theory that could include DPs, methods, models, technological rules, Level3: Grand theories and mid-range theories. This research contributes to both Level2 and Level1 by developing DPs and applying them to an instantiated artefact that was developed through the research.

DPs are regarded as one of the important outcomes of design knowledge (Cronholm & Göbel 2018; Iivari, Hansen & Haj-Bolouri 2018; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). DPs are defined as "knowledge about the creation of other instances of artifacts belonging to the same class" (Kruse, Seidel & Purao 2016, p. 37). The DPs are targeted at the solution designers who would use different ways to apply the DPs to create specific instances.

This research contributes to the DSR body of knowledge through the development of PEKC MRs and DPs. The MRs are DPs are internally, externally, and empirically grounded which is one of the aspects of a good design theory, according to (Goldkuhl 2004).

This research brings the following significant insights into the DSR knowledge.

- This research has developed DPs for a solution class, the PEKC. As the solution class is critical in this knowledge economy, the underpinning DPs also play a pivotal role as they provide prescriptive guidance to the IS developers. The scope of the DPs is broad to cover the socio-technological arena as opposed to focussing only on the technical platform.
- The approach to developing the DPs is also significant as the derivation of the IS DPs from a non-IS external theory is not a typical path of developing the DPs. The IS DPs usually codify the principles to an abstract problem class from an IS artefact. This research's approach of commencing with a management theory, refining the theory to suit IS practice and applying the theory pragmatically to build an IS artefact is novel.
- While the extant researchers acknowledge that the MRs are an important aspect of DSR, there is no systematic process for developing the MRs. This research has used a method by grouping Agile user stories to MRs
- And finally, the evaluation of the DPs by the practitioner community is a significant step toward closing the gap between the research and practitioner community.

4.7.2 *CONTRIBUTIONS TO PRACTICE*

The contribution of this research is significant to ITSM practitioners who play pivotal role in the organisations. The broader ITSM community is a global community with an estimated population of more than half a million practitioners. The community comprises consultants, practice managers, auditors, project managers, DevOps professionals, service desk professionals, technology providers, training providers, certification bodies, students, and higher education institutions. Table 4-7 shows the users from the top-10 countries around the world accessing Service-Symphony from April 2019 to September 2022. The data indicates that there is an interest to consume the holistic knowledge provided by Service-Symphony. The patronage implies that the design of Service-Symphony through the DPs is consistent with the expectations of the practitioners.

TABLE 4-7 USERS BY COUNTRY ACCESSING SERVICE-SYMPHONY

Country	Users
India	25,768
United States	22,588
Australia	6,941
United Kingdom	6,294
Germany	6,187
Indonesia	6,029
Canada	3,990
Netherlands	3,456
Philippines	3,166
South Africa	3,044

To align with the expectations of the practitioners, right from the inception the development of Service-Symphony had representation from ITSMF, Australia. Once Service-Symphony was launched in 2019, ITSMF Australia recognised the contributions of Service-Symphony to the ITSMF community through the "Business of Innovation of the Year 2019", award in their annual conference. This award is one of the evidence that this DSR research's relevance to practice.

4.8 CONCLUSIONS, LIMITATIONS, AND FUTURE WORK

This paper addressed the research question around the formulation and evaluation of DPs, *How can we develop PEKC design principles that are relevant to IS practitioners?*

Though the research question is focused on developing DPs, the end objective of the research is to contribute to the practice through Service-Symphony. Thus, this research paper provides an exemplary DSR case-

study where research can contribute to both DSR theory and practice. The key aspects of our research are:

- Begin with a practitioner problem that impacts a global practitioner community and not confined within any specific organisational boundaries. To manage the scope, we closed worked with a professional body and formed a governance group.
- We also identified an applicable management theory during the early stages of research. This position ensured that theory and artefact design feed each other iteratively.
- We adapted Agile development method to engage the expert panel which ensured that Service-Symphony met the diverse needs of the practitioners
- The expert panel did not have any student representation. We could have benefited from the student perspective if we involved them early on during the design

The researchers acknowledge the following limitations. PEKC theory has been applied in only one expository instantiation in this case, which is a limitation of the DPs evaluation. For a comprehensive study, the design DPs need to be evaluated in different PEKC, including failed systems. Studying both successful and failed systems will validate the assertion about the utility of the DPs.

The small focus group size (n=5) for reusability evaluation is another limitations of the research as the participant feedback could be biased.

We have an ambitious vision to further extend the research to contribute to theory, methodology and practice perspectives. To design an IS artefact, DPs should be considered from multiple perspectives. PEKC DPs

address the knowledge governance aspect of the design. In future, we will be expanding the DPs to address innovation-centric knowledge and cyber-security. The common theory proposed a conceptual model, Institutional Analysis and Development (IAD) framework to systematically analyse the commons (Ostrom 1999; Frischmann, Madison & Strandburg 2014; Albagli et al. 2018). Our future work will consider a more refined design theory comprising MRs, multi-dimensional DPs and a conceptual model. There are research opportunities to refine DSR methodology to align with Agile development. Similarly, we have demonstrated a structured approach of developing MRs. These aspects can be further refined as part of future research. Service-Symphony will be expanded to be included as a complementary learning resource of IT Governance, Project Management, DevOps curriculum. We are discussing with other universities about the possibility of including Service-Symphony in their ITSM curriculum. To expand the value proposition to practitioner, we will be discussing with other professional bodies like ISACA about providing targeted content to their members.

Our work demonstrates that a DSR project can contribute to both theory and practice. The identification of a relevant theory was one of the early steps of this research. The theory reinforced the need to consider community dynamics, instead of focusing only on the technical features. The adaptation of an economic theory to suit IS domain has been an interesting challenge and we believe this work will motivate other researchers to explore ideas from other disciplines to provide inspiration in designing IS artefacts.

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CHAPTER 5 DEVELOPMENT OF DESIGN PRINCIPLES – EPISTEMIC DIMENSIONS

Publication title	Journal/Conference
'The development and application of epistemic logic driven design principles for innovation-centric digital commons'	Under review by *Decision Support Systems* journal

Introduction

This second section of the chapter describes the development of DPs from the epistemic dimension's perspective. Information Systems (IS) practitioners often find it challenging to comprehend frequently changing industry practices and technologies that lead to process innovation. To address this problem, this paper discusses the development of design principles (DPs) for a class of solutions that was defined as INnovation-centric DIgital Commons or INDICO in short. The DPs were formulated based on three epistemic dimensions that underpin innovation-centric knowledge. INDICO DPs were then applied to instantiate a digital commons for Information Technology Service Management (ITSM) practice. The instance, Service-Symphony, was designed to assist ITSM practitioners to innovate and improve service management processes. The Design Science Research (DSR) paradigm was employed in building and evaluating Service-Symphony. The evaluation was undertaken using surveys mapped to the ISO/IEC 25000 standards and web analytics. The survey results indicated that the participants agreed that the three DPs were aligned with Service-Symphony design (DP1: 90%, DP2: 80%, DP3: 98%). The web analytics results indicate that around 13,000 user

sessions utilised Service-Symphony that were aligned with the intended design. The thesis compass of this chapter is shown in Figure 5-1.

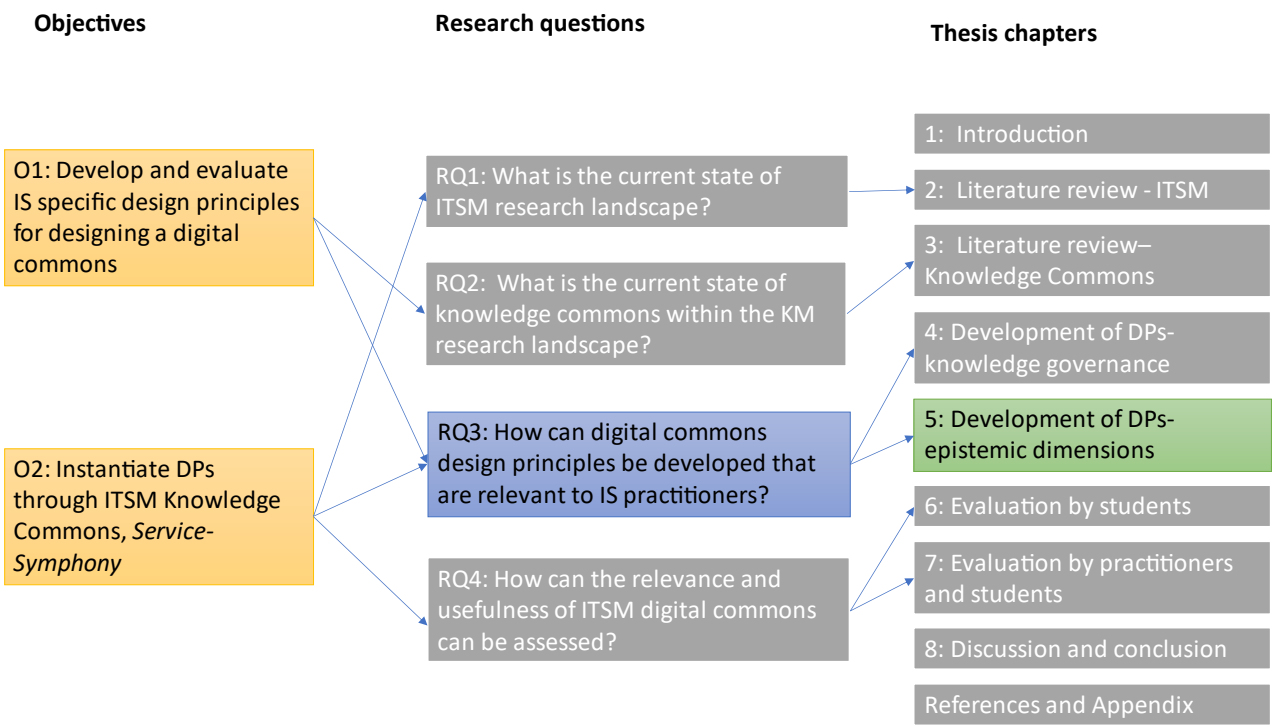

FIGURE 5-1 THESIS COMPASS - CHAPTER 5

The Development & Application of Epistemic Logic Driven Design Principles for Innovation-Centric Digital Commons

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Abstract:

Process innovation refers to the implementation of improved methods by which products and services are created and delivered. Information Systems (IS) practitioners often find it challenging to comprehend frequently changing industry practices and technologies that lead to process innovation. To address this problem, this paper discusses the development of design principles (DPs) for a class of solutions that we defined as "INnovation-centric DIgital Commons" or INDICO in short. The DPs were formulated based on three epistemic dimensions that underpin innovation-centric knowledge. INDICO DPs were then applied to instantiate a digital commons for Information Technology Service Management (ITSM) practice. The instance, *Service-Symphony*, was designed to assist ITSM practitioners to innovate and improve service management processes. The Design Science Research (DSR) paradigm was employed in building and evaluating *Service-Symphony*. The evaluation was undertaken using surveys mapped to the ISO/IEC 25000 standards and web analytics. The survey results indicated that the participants agreed that the three DPs were aligned with *Service-Symphony* design (DP1: 90%, DP2: 80%, DP3: 98%). The web analytics results indicate that around 13,000 user sessions utilised *Service-*

Symphony that were aligned with the intended design. This paper contributes to the research body of knowledge by developing a conceptual model for INDICO and formulating three DPs that are grounded in epistemic logic.

Keywords: IT Service Management, Process Innovation, Knowledge Commons, Design Science Research, Epistemic Logic

5.1 INTRODUCTION

Innovation is the entrepreneurial pursuit of economic value creation by applying existing knowledge in new areas or creating new knowledge (Schumpeter 1934; Camisón & Monfort-Mir 2012; Śledzik 2013). Innovation has shaped human evolution in many ways (Fagerberg 2004), leading to improved health, faster transport, global connectivity, information access, and accessible education. For example, in the recent Covid pandemic, there were innovations in the medical field that was made possible by sharing knowledge about the vaccines and critical information about the virus, its spread, and human responses to various public health measure(Chesbrough 2020).

Rowley, Baregheh and Sambrook (2011) provide a comprehensive mapping that classifies innovation into four types: 1) product innovation, 2) process innovation 3) position innovation (commercial and marketing innovation), and 4) paradigm innovation. We focus on process innovation that supports improvements in the way products and services are created and delivered (Rowley, Baregheh & Sambrook 2011). Process innovation can contribute to competitive advantage and sustainability through increased production, lower life cycle, and efficiency gains (Davenport 1993; Sjödin 2019). Some researchers differentiate between process *improvement* and process *innovation* in terms of the level and intensity of change (Davenport 1993; Mikalef & Krogstie 2020). Despite the distinctions between improvement and innovation, they are interrelated. Hence, many researchers consider innovation and improvement together

(Harkness, Kettinger & Segars 1996; Kautz & Nielsen 2004; Gregor & Hevner 2014; Malinova, Gross & Mendling 2022). In this research context, we adopt a similar position and do not differentiate between process improvement and innovation. For the remainder of this paper, we refer to process innovation to denote both innovation and improvement activities.

Knowledge sharing practices facilitate innovation and firm performance (Wang & Wang 2012; Wang & Hu 2020). A common pool of knowledge is often a precursor to drawing information as well as inspiration for innovation (Allen & Potts 2016; Potts 2019). We define the knowledge that supports improvement and innovation as "innovation-centric knowledge." One of the mechanisms to share knowledge is through the creation of "digital commons." The term "commons" refers to sharing of resources that is subject to social dilemmas (Ostrom 1990; Hess & Ostrom 2007; Laerhoven & Ostrom 2007). Digital commons is a sub-set of commons where the data, information, knowledge, intellectual property, and community wisdom are created and shared online (Dulong de Rosnay & Stalder 2020). To delineate our solution area more specifically, we coined the term INnovation-centric DIgital COmmons or INDICO in short, to indicate a digital commons that shares innovation-centric knowledge.

Although the use of digital commons is researched, there is a lack of prescriptive guidance for IS practitioners to systematically develop and use a digital commons within the Information Systems (IS) practice. These prescriptive guidelines are often formulated through Design Principles (DPs) (Gregor, Müller & Seidel 2013; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). The formulation of DPs is one of the salient outcomes of research that conveys design knowledge (Chandra, Seidel & Gregor 2015; Cronholm & Göbel 2018; Gregor, Chandra Kruse & Seidel 2020).

The Commons theory originally developed by Ostrom(Hess & Ostrom 2007) included a set of DPs that provided guidance for governing resources, including knowledge. The extant research is limited to applying Ostrom's DPs to digital commons (Viégas, Wattenberg & McKeon 2007; Forte, Larco & Bruckman 2009; Safner 2016; Gazi & Sahdev 2022; Linåker & Runeson 2022). While knowledge governance is an important aspect of digital commons, we argue that the existing knowledge governance DPs are not adequate for providing innovation-centric knowledge, because the focus of governance DPs is limited to efficiency utilisation of any shared resource. The governance DPs do not consider the unique attributes of knowledge and hence do not offer any guidelines to design an INDICO. In this research, we posit that epistemic dimensions are one of the fundamental aspects of fostering innovation-centric knowledge. Epistemic dimensions are based on epistemic logic that can be grouped in three categories: self-knowledge, common knowledge, and distributed knowledge (Ditmarsch et al. 2015). We hypothesised that these epistemic dimensions are essential to address innovation-centric knowledge and hence critical to designing an INDICO.

The DPs were instantiated by building an artefact that we refer to as "*Service-Symphony*". This artefact supports Information Technology Service Management (ITSM) practitioners in process innovation. ITSM is a set of specialized organisational capabilities for enabling value in the form of IT services (Axelos 2019). ITSM practice encompasses many complementary process frameworks that are developed and maintained by the practitioner community. These frameworks are widely adopted as best practices in different professional settings such as Governance, Project Management, Systems Development, and Software Engineering (Cater-Steel, Tan & Toleman 2006; Pardo et al. 2012b).

Deciding about the right ITSM process frameworks can be a challenge due to a lack of knowledge about existing frameworks and their relationship with other frameworks (Valiente, Garcia-Barriocanal & Sicilia

2012; Mejia, Muñoz & Muñoz 2016). The existence of multiple process frameworks can cause confusion, inefficiency, and ineffectiveness (Heston & Phifer 2011). A lack of understanding of the process landscape is an impediment to process improvement and innovation (Heston & Phifer 2011; Valiente, Garcia-Barriocanal & Sicilia 2012; Pardo et al. 2013; Mejia, Muñoz & Muñoz 2016). On the other hand, this research argues that the existence of diverse process frameworks is a catalyst to innovation if there is adequate comprehension of diversity and how knowledge can be leveraged from a diverse knowledge pool. There was an opportunity in ITSM knowledge to provide a holistic view of all the frameworks which led us to the development of *Service-Symphony*.

This research aims to answer the question, "*Can design principles based on epistemic logic aid in the development of a digital commons that provides knowledge towards ITSM process innovation?"*

The research follows the design science research (DSR) paradigm (Hevner et al. 2004; Baskerville et al. 2018), which is suited for research involving the design and evaluation of IS artefacts (Peffers et al. 2007; Hevner et al. 2008; Vaishnavi & Kuechler 2015; Peffers, Tuunanen & Niehaves 2018). The paper makes the following significant contributions to the body of knowledge: (1) developing DPs and a conceptual model based on epistemic logic for INDICO (2) applying the DPs to develop *Service-Symphony* and (3) evaluation of *Service-Symphony* against the DPs.

This paper follows the structure proposed by (Gregor & Hevner 2013b) to present DSR research. The remainder of the paper is organised as follows. The theoretical background section analyses the innovation centric knowledge through the lens of epistemic dimensions and builds a conceptual model for INDICO. The methodology section describes the steps followed in designing and evaluating the artefact. The evaluation section describes the evaluation strategy and the results of the evaluation. The discussion and conclusion section reflects on the

approach, results, and implications. This research concludes by acknowledging limitations and identifying future research opportunities.

5.2 THEORETICAL BACKGROUND

Epistemology is the study of knowledge that has a long tradition in philosophy, starting with the early Greek philosophers and applied in diverse fields including economics, computer science, and Artificial Intelligence (Fagin et al. 2004; Meyer & Van Der Hoek 2004). Epistemic logic is a study of systemic properties of knowledge (Hendricks 2015).

Epistemic logic is highly relevant in IS research as it helps to formalise reasoning methods and provides a logical approach to decision making and developing formal descriptions (Meyer & Van Der Hoek 2004). We analyse the three categories of epistemic dimensions viz., self-knowledge, common knowledge, and distributed knowledge as they are the key components of Innovation-centric knowledge, which is explained in the next section.

5.2.1 INNOVATION-CENTRIC KNOWLEDGE

"*Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace*" (Baregheh, Rowley & Sambrook 2009, p. 1334). Innovation involves using existing knowledge as well as acquiring and generating new knowledge (Howells 2000). The process of moving from existing knowledge to new patterns of knowledge involves learning. Knowledge is a holistic process, but it is also individualistic. Although individuals cannot be considered as the "islands of knowledge," as we share and learn from each other, eventually knowledge is filtered, perceived, and stored at an individual level (Howells 2000). Since each individual has their own mental frame, it can be difficult to share common knowledge amongst individuals. Establishing common knowledge is one of

the important steps in fostering innovation as it enables communication and collaboration between individuals.

Knowledge is considered to be 'distributed' since it emerges primarily through social interactions (Kirkman 2016). Tsoukas (1996) observes that there are two schools of thought to classify knowledge. The first group of researchers, including Polanyi (1961) and Nonaka (1994), propose a typology-based model that classifies knowledge as tacit and explicit. Although the contributions of this typology approach have clarified our understanding of organisational knowledge, there are limitations to this approach. Tacit and explicit knowledge are not dichotomous as they are inseparable (Tsoukas 1996). The second group of researchers attempt to model organisations as similar to human brains or collective minds. Weick and Roberts (1993) observe that the collective mind is a distributed knowledge system. The distributed knowledge system stream of research avoids the dichotomies inherent in the typologies of organizational knowledge.

Although gaining knowledge and being innovative is individual-centric, the role of common knowledge and distributed knowledge are essential to promote innovation at an organizational level. Common knowledge enables the individual to gain an understanding of "what other people know" about a problem and potential solutions. Common knowledge accelerates innovation as it enables the individual innovators operating in silos to communicate with peers using a common language and a clear understanding of their positions. The following section describes the categories of self-knowledge, common knowledge, and distributed knowledge through the epistemic logic lens.

5.2.2 SELF-KNOWLEDGE:

Self-knowledge implies that the innovating agent is aware that they know a proposition "p". Self-awareness is gained through introspection. Introspection is defined as an "ongoing process of tracking, experiencing,

and reflecting on one's thoughts, mental images, feelings, sensations, and behaviours" (Gould 1995, p. 719). One of the preconditions of introspection is that the person introspecting should be knowledgeable to some extent in the topic under consideration (Gould 1995; Xue & Desmet 2019). Therefore, self-knowledge is a foundation to build common knowledge.

5.2.3 COMMON KNOWLEDGE:

Epistemic logic is based on the *possible worlds* model that can be explained through a classic puzzle presented by Fagin et al. (2004). Let us consider a scenario where two children, Alice and Bob, are playing in the park and a parent strictly instructed them not to get dirty. Both have mud on their forehead. The parent declares "*At least one of you has mud on your forehead*" and asks the question "*Do you know if you have a dirty forehead*?". Each child cannot see their forehead. When the parent asks the first time, the reply will be "*No*" from both of them. However, when the parent asks the second time, both will answer "*Yes*". When Bob answers "*No*" for the first time, Alice recognizes there must be mud on her forehead, or else, Bob would have answered "*Yes*". The assumption behind the puzzle is that the children are perceptive, intelligent, truthful, and answer simultaneously.

In this concept of the *possible worlds*, besides the true state of events, there are other possible states of events, or "worlds". If we extend the example to multiple children, in which Alice notices that Bob has a muddy forehead, and no other children have muddy foreheads. This allows Alice to eliminate all but two worlds:

- Bob and Alice have muddy foreheads and the other children are clean
- Only Bob has a muddy forehead, and the other children are clean.

The knowledge provided by the parent is important. The proposition *p* is "at least one of you has a muddy forehead." This proposition is not new to the children as they can see each other. By announcing this proposition, the parent makes sure that "everyone knows that everyone knows *p*". This notion is called *common knowledge*.

5.2.4 *DISTRIBUTED KNOWLEDGE*

Distributed knowledge is another aspect of epistemic logic (Fagin et al. 2004; Roelofsen 2007). Consider Alice and Bob sitting in a closed room in Sydney. They are wondering whether it is a sunny day. Alice and Bob have a common friend Charlie. Alice knows that Charlie plays cricket only on sunny days. Bob mentions to Alice that he just met Charlie outside the building. Combining these two pieces of information, Alice and Bob can conclude that it is not a sunny day. The concept of distributed knowledge can be extended to organisations and communities. In the organisational context, no single agent can fully specify in advance what kind of practical knowledge is going to be relevant to the organisation. Therefore, organisations are to be considered as distributed knowledge systems. (Tsoukas 1996). Epistemically, the distributed knowledge can be expressed as "*a formula φ is distributed knowledge among a group of agents B iff φ follows from the knowledge of all individual agents in B put together*" (Roelofsen 2007, p. 255). This statement represents the ideal condition of distributed knowledge that expects the knowledge is distributed to all the agents within the group. In practice, we interpret the statement as, "*A solution S is distributed knowledge among a group of agents G iff S is derived from the knowledge of some or all of the individual agents in G put together*." This statement acknowledges the solution knowledge is broader than an individual agent, but not necessarily needs inputs from *all* the agents within the group. Hewitt and Scardamalia (1998) point out the human cognition do not just reside "in

the head" of one individual but is distributed among other individuals and influenced by the surroundings.

Table 5-1 summarises the three categories of epistemic dimensions.

TABLE 5-1 EPISTEMIC DIMENSIONS

Epistemic dimensions	Description	Interpretation
Self-knowledge	Self-aware, introspection of knowledge	Agent a knows that agent a knows proposition p
Common knowledge	All members of the group know about a fact, and they know that the other members also know the fact	All agents in a group know proposition p; All agents know that the other agents in the group know proposition p.
Distributed knowledge	The group collectively knows the solution to a problem	A solution S is distributed knowledge among a group of agents G iff S is derived from the knowledge of some or all individual agents in G put together

The self-knowledge of the agent is based on their prior knowledge, experience, and environment. The foundational impetus for innovation is through self-knowledge. In our research context, the role of INDICO is to stimulate the agent to reflect and introspect about what they know.

Common knowledge allows the agent to collaborate with other agents within the domain. INDICO plays a pivotal role in disseminating common knowledge. INDICO equips the agent with common terminology, best practices and pointers to further resources and communities.

The distributed knowledge space is broader than the common knowledge space. The distributed knowledge can lie within the domain or outside the domain. For example, if an innovator is conducting research in metallurgy, all the related sub-domains within metallurgy are considered as distributed knowledge within the domain. The innovator can get inspiration and complementary knowledge from other domains not related to metallurgy. The conceptual diagram acknowledges the role of 'external' distributed knowledge.

Distributed knowledge within a domain can be accessed by the agent through INDICO. It is possible that once the initial knowledge is gained, the agent can directly interact with practice communities to gain more knowledge about specific practices. Figure 5-2 provides a conceptual model of INDICO.

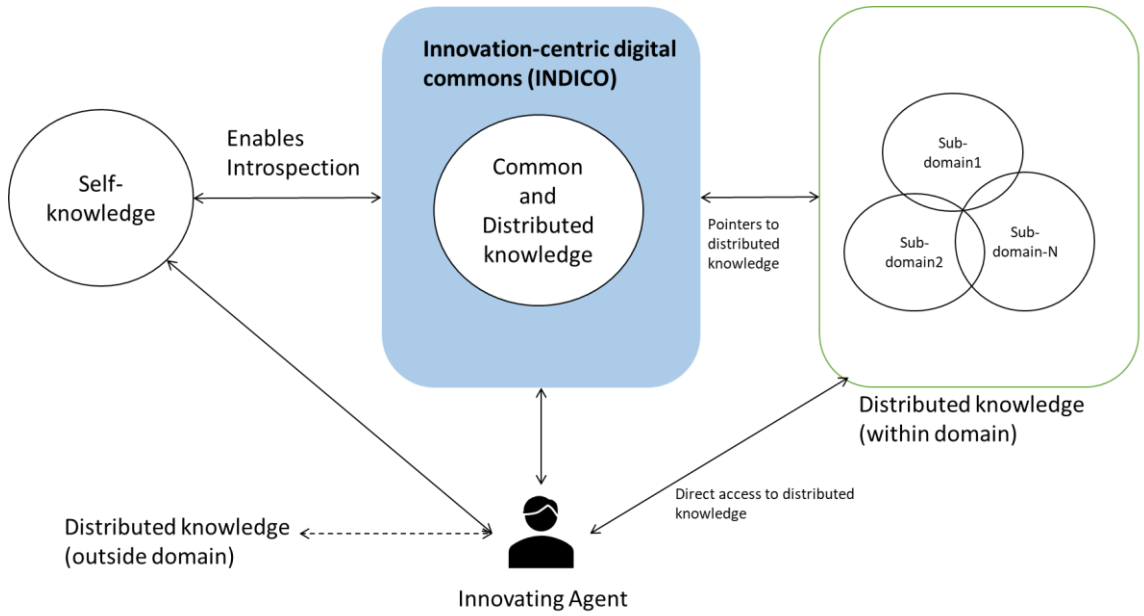

FIGURE 5-2 CONCEPTUAL MODEL OF INDICO

5.3 RESEARCH METHOD

This research follows the DSR paradigm which addresses the "relevance versus rigour" gap in IS research (Hevner et al. 2004; Baskerville et al. 2018). DSR involves two primary activities: (1) the creation of new knowledge through the design of novel or innovative artefacts; and (2) the analysis of the artefact's use and/or performance (Vaishnavi & Kuechler 2015). This research follows a six-step DSR approach comprising (1) Problem identification and motivation, (2) Objectives of a solution, (3) Design and development, (4) Demonstration, (5) Evaluation, and (6) Communication (Peffers et al. 2007).

5.3.1 PROBLEM IDENTIFICATION AND MOTIVATION

In Step 1, the problem of multi-process complexity was identified through industry participation and validated through a literature review. The literature review and the industry feedback pointed to an opportunity to develop *Service-Symphony*.

5.3.2 OBJECTIVES OF A SOLUTION

Iivari (2015) points out that there can be two strategies in DSR depending upon the intent and nature of the IS artefact. In the first strategy, a general solution concept to address a class of problems is built by the researcher. In the second strategy, a client's specific problem is solved through the IS artefact. Our research is aligned to the first strategy as our research is focused on a general problem without a specific client. As there was no single client, we formed an expert panel to represent the practitioner community. The expert panel served as a mechanism for brainstorming ideas and refining objectives and requirements (Step 2). The five-panel members were experts with over twenty years of experience each and participated voluntarily. The members came from diverse backgrounds including freelance consulting, Chief Information Officer (CIO), private and government sectors. Two

members were nominated by the IT Service Management Forum (ITSMF) in Australia, which is the peak body representing ITSM professionals. Globally, the itSMF has membership of over 6000 companies, and around 40,000 individuals spread over 50+ Chapters (ITSMFInternational 2022). Based on the inputs from the expert panel, the need for a digital commons to provide a holistic view of ITSM landscape emerged. Based on these inputs, the following research solution was developed:

"*Develop a knowledge repository for ITSM practice that provides a holistic view of processes and tools and provides pointers to relevant resources to help practitioners plan process innovation within their organisations*."

The expert panel viewed the repository as a "container of holistic knowledge" that continually grows and stays relevant. It was clear that we were not intending to create any new knowledge but curate knowledge from existing frameworks, as each framework had a detailed body of knowledge, training, and tools. We asked ourselves, "*what is the value of a knowledge repository if we are not creating any new knowledge*?" We attempted to answer this question through the lens of epistemic knowledge, which is explained in the next step.

5.3.3 DESIGN AND DEVELOPMENT

Step 3 of the DSR process, design and development, is described in this section. The design and development began with consideration of epistemic logic as a basis for DPs to guide artefact development. DPs are prescriptive statements that describe the method for achieving a defined objective (Gregor & Jones 2007; Gregor, Chandra Kruse & Seidel 2020). DPs are one of the major research outcomes of DSR (Chandra, Seidel & Gregor 2015; Gregor, Chandra Kruse & Seidel 2020; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021).

This research derived three DPs for INDICO based on self-knowledge, common knowledge, and distributed knowledge aspects of epistemic logic.

In the language of epistemic logic, this paper uses the notation K_{ap} for "agent *a* knows that *p* is the case." The term "*p*" can stand for any proposition. It could be as simple as "Anne knows Bob has mud on his head" or "Organisation-A knows that a risk assessment is important in project management".

Epistemic logic allows the expression of "knowledge about knowledge". For example, let us assume Anne sends an email to Bob which is read by Bob. The email can be about any proposition "*p*," say "let us meet at 6 pm for a coffee". The statement will be:

$$K_{bp} \ \hat{} \ K_b K_{ap}$$

The statement expresses that agent *b* knows proposition *p* AND agent *b* knows that agent *a* knows proposition *p*.

3.3.1 Principle of introspection-centricity*:* In epistemic terms, when the agent knows a proposition, it implies that "*agent know that they know what they know*." The epistemic statement that represents introspection is:

$$K_a K_{ap}$$

where agent *a* knows that agent *a* knows proposition *p*.

This principle differentiates between "knowing something" and "awareness of knowing something." There could be many reasons why an agent may not realise what they already know. One of the reasons could be the use of different terminologies. For example, the term "incident" and "problem" have specific meanings in the context of ITSM. The "problem" is a term used to describe the underlying cause of incidents. If we ask a whitegoods mechanic if they know "problem management," they may likely to answer negatively. Once they are made aware that problem

management deals with root-cause analysis and troubleshooting, they will be able to relate to it. The potential design features that can help to validate the self-awareness of the knowledge are pointers to training and assessments.

In this context, the first DP can be stated as follows:

DP1: An INDICO should enable users to reflect and assess their knowledge and skills within the practice domain.

Principle of common knowledge centricity: The common knowledge concept of epistemology is closely related to the introspection centricity discussed in section 3.3.1. The common knowledge should be communicated to the group of agents within the solution domain. Each member of the group should have an understanding that the other members in the group are aware of the knowledge. For example, within the ITSM domain if two members discuss "problem management", both are aware of the context, process steps and outcomes expected from problem management. To achieve common knowledge, the knowledge provided in INDICO should be relevant to practitioners. Epistemically common knowledge centricity can be expressed as follows:

$$K_a K_{bp} \quad \hat{} \quad K_b K_{ap}$$

The expression states that agent a knows that agent b knows proposition "p" and agent b knows that agent a knows proposition "p".

Design features that support the principle of common knowledge centricity could include an unified page that presents a holistic view of the domain and effective search and compare features to explore the practice sub-domains.

In this context, the DP can be stated as follows:

DP2: An INDICO should provide common knowledge within the practice domain.

Principle of knowledge diversity: One of the ways to innovate is to combine different knowledge areas in a novel way or combine previously unconnected knowledge areas (Nahapiet & Ghoshal 1998; Ruiz-Jiménez & del Mar Fuentes-Fuentes 2013). Allowing for knowledge diversity ensures that the innovating agent is aware of diverse knowledge within and outside of the domain. For INDICO, the scope of diversity is limited to providing diverse knowledge within the chosen domain. The epistemic expression that underpins the principle of knowledge diversity can be stated as follows:

$K_{ap} \wedge K_{aq} \wedge K_{ar}$

$p \in SD1, q \in SD2, r \in SD3$

Where *p*, *q*, and *r* are propositions from separate knowledge sub-domains *SD1, SD2 and SD3*.

The design principle in this context can be stated as follows:

DP3: An INDICO should contain diverse knowledge that can be searched and compared across different practice sub-domains.

The mapping of epistemic dimensions, DPs and potential design features are summarised in Table 5-2.

TABLE 5-2 MAPPING BETWEEN EPISTEMIC DIMENSIONS, DPS AND POTENTIAL DESIGN FEATURES

Epistemic dimensions	**DPs**	**Description**	**Potential Design features of an instantiated artefact**
Self-knowledge	Introspection centricity	An INDICO should have design features that enable	Providing relevant knowledge to trigger introspection.

		the users to reflect and assess their skills within the practice domain.	Pointers to self-assessment of skills. Assessment instruments.
Common knowledge	Common knowledge centricity	An INDICO should provide common knowledge within the practice domain.	Unified landing page. Group announcements. Links to related topics. Pointers to external sources.
Distributed knowledge (within a practice domain)	Knowledge diversity	An INDICO should contain diverse knowledge across different sub-domains that can be explored by the user through searching and comparing.	Information search. Collaboration features.

5.3.4 DEMONSTRATION OF THE APPLICATION OF DPS

Adopting the three proposed DPs, *Service-Symphony* was developed using an open-source Content Management System (CMS) (O'Neill 2017; Cabot 2018). The application development used a configurable platform approach that streamlined the application development process (Rodas-Silva et al. 2019). While designing *Service-Symphony*, this research

applied the three DPs of introspection centricity, common knowledge, and knowledge diversity through design features. The next section discusses the design features of *Service-Symphony* that support the DPs.

5.3.4.1 APPLYING THE PRINCIPLE OF INTROSPECTION-CENTRICITY:

Introspection-centricity attempts to fulfil one of the pre-conditions of introspection, i.e., the agent should have some prior knowledge about the topic being considered (Gould 1995; Xue & Desmet 2019) . *Service-Symphony* design should enable users to introspect if they find the content relevant to them and easy to comprehend. The information architecture of *Service-Symphony* enables the user to comprehend the ITSM landscape holistically. In addition, monitoring and feedback mechanisms were implemented including web analytics and user posting to ensure that the content stays relevant to the practitioners. Knowledge articles included also point to the Skills Framework for the Information Age (SFIA) that provides a competency framework for practitioners to assess their skill levels.

5.3.4.2 APPLYING THE PRINCIPLE OF COMMON KNOWLEDGE CENTRICITY

Service-Symphony is designed to provide an overview of relevant process frameworks. It describes all the processes and sub-processes within the frameworks. In the current version, *Service-Symphony* contains knowledge of 12 process frameworks, 11 service lifecycle stages, 35 processes, and 16 tools. *Service-Symphony* users can get a holistic view of the common frameworks, tools and lifecycles. This unified view enables the agents to gain an understanding of the overall landscape. By exploring the frameworks further, the agents can understand the common terminology, guiding principles, and best practices of each framework.

5.3.4.3 APPLYING THE PRINCIPLE OF KNOWLEDGE DIVERSITY

Service-Symphony provides diverse knowledge within the ITSM domain. We carefully considered the boundaries of the domain. If a domain is

defined too narrowly, the opportunity to draw from diverse knowledge is lost. If the domain is defined too broadly, the relevance to practice will be lost. In designing *Service-Symphony*, we defined broad boundaries of the ITSM domain encompassing IT Governance, service management, project management, enterprise architecture, DevOps and continual service improvement. The frameworks underpinning these sub-domains have overlapping aspects as well as diverse aspects. *Service-Symphony* enables its users to search in different ways, including

across all frameworks, lifecycle, processes, tools, skills

within a specific framework (for example, within ITIL4 framework)

within a specific framework and with specific granularity (for example, within ITIL4 and across relevant process/practices)

side-by-side comparison of specific frameworks.

The organisation of *Service-Symphony* is shown in Figure 5-3

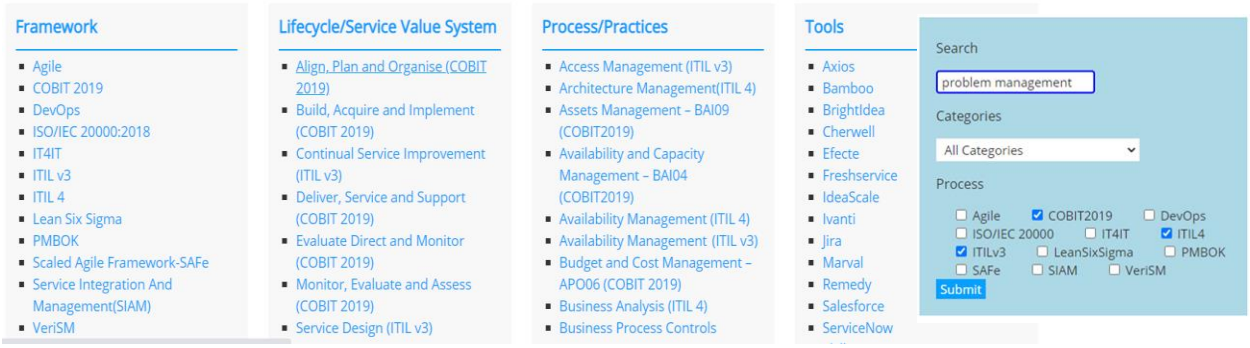

FIGURE 5-3 APPLYING THE PRINCIPLE OF KNOWLEDGE DIVERSITY

5.4 EVALUATION

This section addresses the step 5 activity, evaluation, of the six step DSR approach this research followed. DSR advocates for rigorous evaluation of the developed artefacts (Peffers et al. 2012; Venable, Pries-Heje & Baskerville 2016). The Framework for Evaluation in Design Science Research (FEDS) (Venable, Pries-Heje & Baskerville 2016) classifies evaluation into formative and summative evaluation and proposes different strategies. Our summative evaluation follows the Human Risk &

Effectiveness strategy that advocates practitioners evaluating the artefact in a naturalistic setting. More specifically, the evaluation approach utilized methodical triangulation. Methodological triangulation considers more than one quantitative or qualitative data source or method to evaluate a phenomenon or product (Jack & Raturi 2006; Bekhet & Zauszniewski 2012). The methodical triangulation overcomes the inherent flaws of a single evaluation instrument and enable researchers to derive better-founded conclusions (Jack & Raturi 2006). This research conducted surveys and used web behavioural analytics (Plaza 2011; Saura, Palos-Sánchez & Cerdá Suárez 2017) to evaluate the DPs alignment with the *Service-Symphony* design. Figure 5-4 shows the methodical triangulation approach.

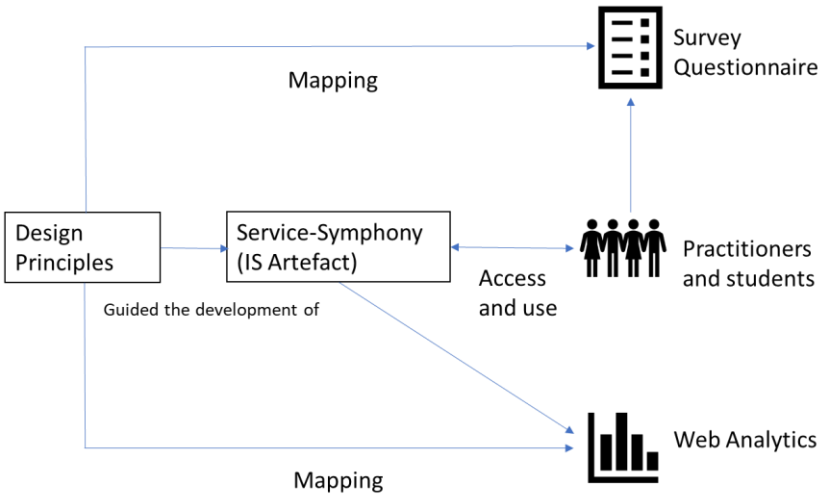

FIGURE 5-4 METHODICAL TRIANGULATION APPROACH TO EVALUATING DPS

5.4.1 SURVEY RESPONSES ANALYSIS

A survey was used to evaluate the perceptions of industry practitioners (n=26) and University students who were pursuing ITSM studies (n=14) on the relevance *Service-Symphony*. The industry practitioners were recruited during a professional networking seminar conducted by ITSMF. The prominent group of respondents was from large government and defence organisations with more than 2000 employees and had more than 20 years of experience. The students were recruited through the

course coordinator of ITSM course in which students were enrolled in. The survey was conducted in compliance with the University's ethical research policy and no personally identifiable data was collected. The survey included questions to calculate the Net Promoter Score (NPS) and assess *quality-in-use* characteristics aligned with ISO/IEC 25000. The NPS is derived from responses to a single question that queries whether the user would recommend the product to a friend or colleague (Reichheld & Covey 2006). The ISO/IEC 25000 series, known by the abbreviation SQuaRE (Software product Quality Requirements and Evaluation) series includes standards that define characteristics for internal and external quality and for *quality in-use* (Bøegh 2008). The quality-in-use characteristics were assessed by inviting the audience to respond to the questions in a five-point Likert scale (strongly agree, agree, neutral, disagree and strongly disagree). The list of survey questions is provided in Appendix-B.
Figure 5-5 shows the mapping between the DPs and survey questions.

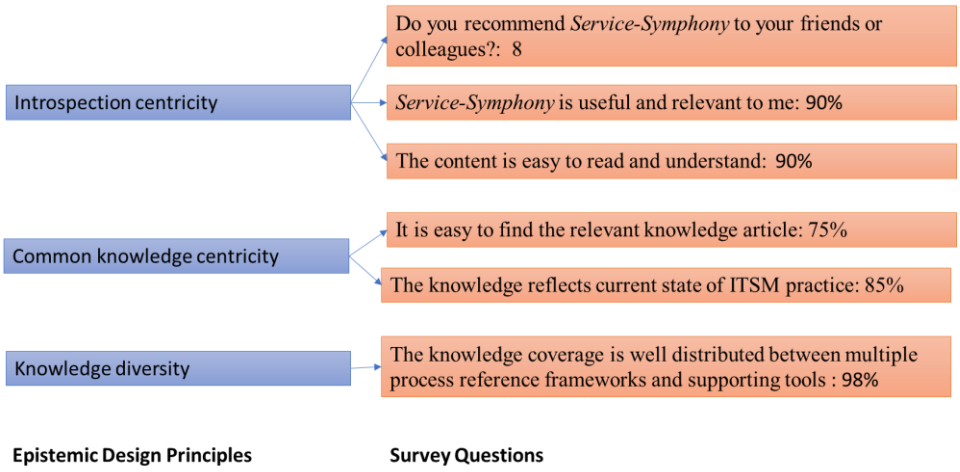

FIGURE 5-5 MAPPING BETWEEN EPISTEMIC DPS AND SURVEY QUESTIONS

We interpret the term "introspection" pragmatically as enabling the participant to reflect on what they already know and to build new knowledge. We hypothesised that introspective learning occurs when the participant finds the knowledge presented is useful and relevant to them. One of the indicators to determine the usefulness is through the evaluation of the NPS. The NPS is calculated based on the response to a

question, "Do you recommend ITSM knowledge repository to your friends or colleagues?" with a rating of zero (0) to ten (10). Promoters include anyone who responds with a score of nine (9) or ten (10). Detractors are those who score between zero (0) and six (6). NPS is determined by subtracting the percentage of detractors from the percentage of promoters (Lee 2018). The survey responses resulted in 28% promoters, and 20% detractors resulting in the NPS of 8. A score above zero is considered favourable as it implies that there are more promoters than detractors. For the questions as to whether *Service-Symphony* was useful and relevant, easy to read and understand, 90% of the participants agreed. Thus, we observe that the introspection-centricity dimension is addressed by *Service-Symphony* as the participants indicated the product was relevant and useful to them.

The DPs for Common knowledge centricity were assessed through searchability and currency. The responses to searchability ("it is easy to find the relevant knowledge article": 75%) and currency ("the knowledge reflects the current ITSM practice": 85%) resulted in an average score of 80%. The results indicated that there were improvement opportunities in searchability.

The knowledge diversity was measured through the response of the question "the knowledge coverage is well distributed ". The 98% agreement on the responses to knowledge diversity indicated that the *Service-Symphony* design enabled the participants to get diverse knowledge from different sub-domains within the ITSM domain.

5.4.2 USER BEHAVIOUR ANALYSIS THROUGH WEB ANALYTICS

This research also utilized Google Analytics for monitoring the performance of *Service-Symphony*. Google Analytics has been used to analyse diverse types of web portals including academic courses (Yamba-Yugsi, Luján-Mora & Pacheco-Romero 2019), tourism websites (Plaza 2011; Gunter & Önder 2016), library websites (Fang 2007) and e-

commerce sites (Hasan, Morris & Probets 2009). Figure 5-6 shows the mapping between the DPs and Web Analytics metrics.

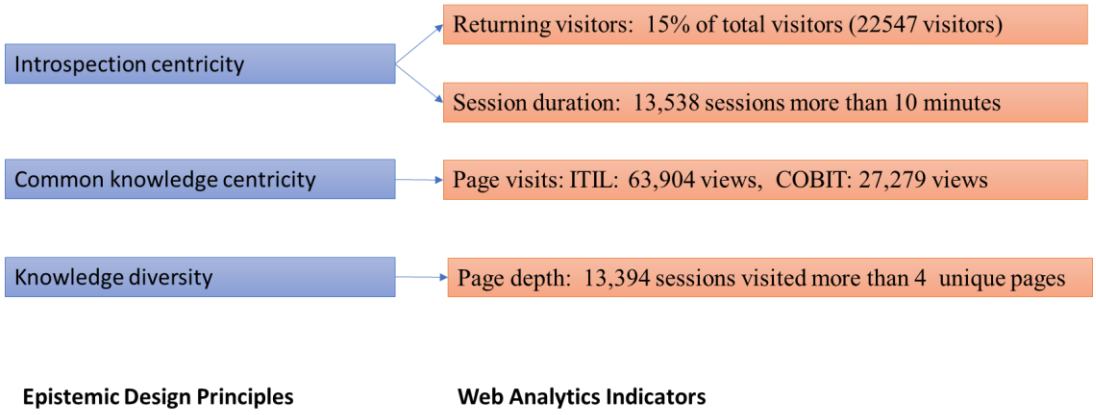

FIGURE 5-6 MAPPING BETWEEN EPISTEMIC DPS AND WEB ANALYTICS INDICATORS

Returning visitors metrics was considered as an indicator for introspection centricity. We hypothesised that if the users find *Service-Symphony* knowledge relevant to them, they are likely to return. Figure 5-7 indicates that over 15% of visitors (22,547) visit *Service-Symphony* more than once.

FIGURE 5-7 WEB ANALYTICS METRICS - RETURNING VISITORS

Another indicator for introspection-centricity was the time spent on *Service-Symphony*. When the user spends considerable time, they are likely to be reflecting on the knowledge provided. Figure 5-8 shows a histogram where the second and third rows show the number of sessions from 10 minutes to 30 minutes and more than 30 minutes, respectively. We assume that if a user spends more than 10 minutes on a session, the

user is engaged in some learning and reflecting. The histogram shows that 13,538 sessions (a total of 10,148 and 3,390) were for more than 10 minutes.

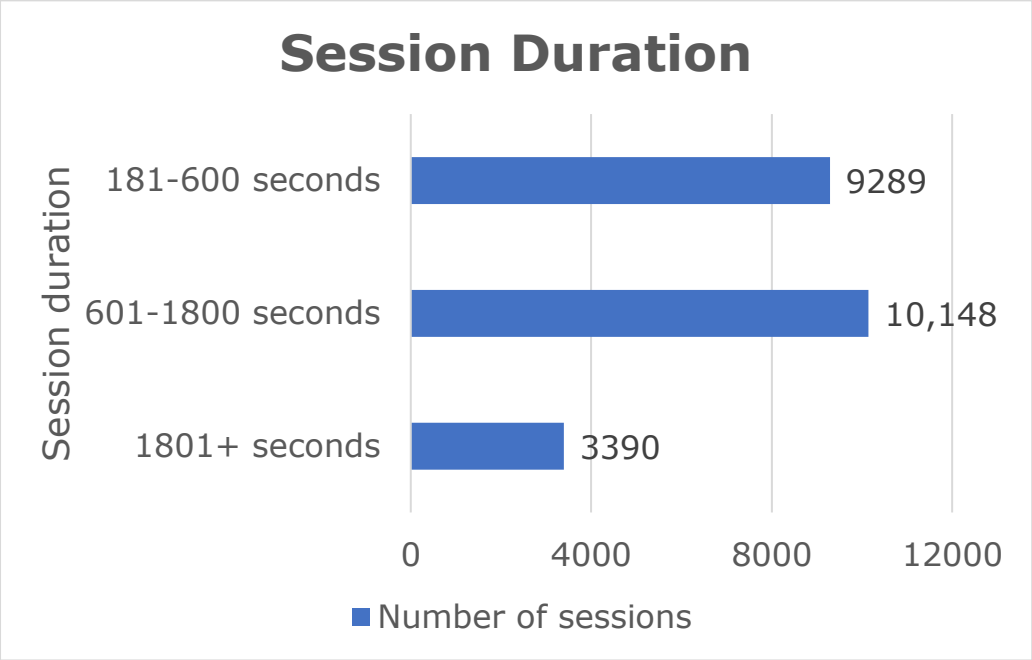

FIGURE 5-8 WEB ANALYTICS METRICS - SESSION DURATION HISTOGRAM

The Common knowledge centricity DP was monitored through the page views. *Service-Symphony* shows the holistic view of all the related frameworks so that the practitioners get an appreciation of common knowledge across the ITSM practice. Figure 5-9 shows that most users were interested in gaining common knowledge about ITIL4 (63,904 page views) , followed by COBIT (27,279 page views). The visit to the root page (/) shows 9678 page views and indicates the number of users who obtained an overview of all the process frameworks.

	Page	Pageviews
		315,039 % of Total: 100.00% (315,039)
1.	/framework/lifecycle/service-value-systemitil-4/	24,755 (7.86%)
2.	/framework/lifecycle/process/monitoring-and-event-management-itil-4/	9,921 (3.15%)
3.	/	9,678 (3.07%)
4.	/framework/itil-4/	8,420 (2.67%)
5.	/framework/cobit/	7,574 (2.40%)
6.	/framework/lifecycle/process/service-configuration-management-itil-4/	7,283 (2.31%)
7.	/framework/lifecycle/process/deployment-management-itil-4/	6,941 (2.20%)
8.	/uncategorized/security-service-management-dss05-cobit2019/	6,672 (2.12%)
9.	/framework/lifecycle/process/capacity-and-performance-management-itil-4/	6,584 (2.09%)
10.	/framework/lifecycle/evaluate-direct-and-monitor-cobit/	5,459 (1.73%)

FIGURE 5-9 WEB ANALYTICS METRICS - PAGE VIEWS

The knowledge diversity DP was assessed through the page-depth metrics. If the visitor accesses multiple pages, they are gaining knowledge from diverse knowledge bases within the ITSM domain. The pie chart in Figure 5-10 suggests that most casual visitors accessed less than 4 pages. There were, however, 13,394 user sessions in which there were more than 4 unique pages visited per session. These sessions indicate an 8% of non-casual, power users (represented by 13,394 sessions) who were interested in gaining knowledge from diverse sources.

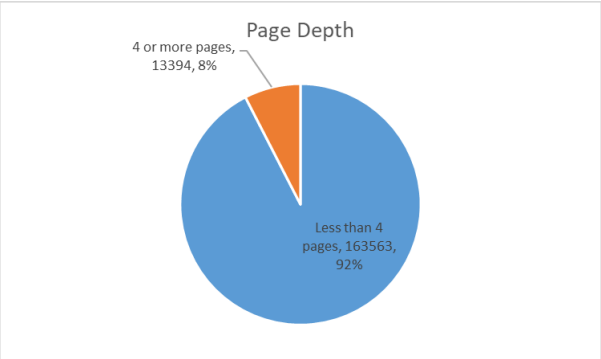

FIGURE 5-10 WEB ANALYTICS METRICS - PAGE DEPTH

5.5 DISCUSSION AND CONCLUSION

This research addressed the research question "*Can design principles based on epistemic logic aid in the development of a digital commons that provides knowledge towards ITSM process innovation?"* The answer to the question has two components, namely the formulation of INDICO DPs based on epistemic logic and the instantiation of *Service-Symphony*, a digital commons for ITSM practice that can support improvement/innovation. This research demonstrated a systematic approach for formulating epistemic DPs and pragmatically applying those DPs to build a digital commons. The survey results and web analytics indicate that the digital commons is aligned with the DPs and hence could support process innovation in ITSM.

We followed the six-step approach for the DSR project (Peffers et al. 2007). The first five steps are aligned with the sections in this paper. The last step of the process, communication, is being achieved through academic publications and industry demonstrations. Using the epistemic logic, this research developed a conceptual model and DPs for INDICO from an epistemic dimensions' perspective. The epistemic dimensions are not necessarily obvious to the designers of digital commons, an observation supported by the fact that they have not, to our knowledge, been elucidated in the literature. The extant research focuses primarily on the knowledge governance DPs (Forte, Larco & Bruckman 2009; Frischmann, Madison & Strandburg 2014; Safner 2016; Dulong de Rosnay & Stalder 2020)of the digital commons that were derived from Ostrom's commons theory(Ostrom 1990). Using the Ostrom's DPs do not differentiate knowledge attributes that are necessary for innovation hence do not offer any prescriptive guidance for IS practitioners to design INDICO. Thus, the epistemic DPs provide a critical and novel perspective to designing a digital commons that underpins innovation. To bridge theory and practice, we instantiated the DPs through a purpose-built, public domain *Service-Symphony* instance.

The epistemic dimension enables us to articulate the value of *Service-Symphony* by showing how it can be differentiated from other portals. A specific digital resource, such as an ITIL book, does not provide common knowledge and diverse knowledge. On the other hand, when an agent visits a generic portal like Wikipedia, it is the responsibility of the agent to identify the domain boundaries and search the knowledge within the domain. As indicated by the participant feedback and behaviours, the knowledge provided by *Service-Symphony* is balanced between the extremes of the specialised, narrow knowledge and the broad, diverse knowledge.

In the muddy children puzzle, the key role of the parent is to make each child aware that the other child also knows the proposition so that the children can make deductions based on this common knowledge. Translating this puzzle to an IT organization practice, we can observe, for example, if an organisation is preparing for a COBIT audit, the key stakeholders could visit *Service-Symphony* to research about COBIT. All the stakeholders would gain knowledge and be aware that the other stakeholders who must have the common knowledge.

For distributed knowledge, the analogy demonstrated how Alice and Bob figured out whether it was a sunny day by combining the individual pieces of information they had. In ITSM practice, if an Operations manager and a Delivery Manager want to implement DevOps practice, they can clarify and combine their collective knowledge to better develop DevOps practice. Thus, our claim is that *Service-Symphony* addresses all the epistemic dimensions and provides a unique value to practitioners using digital commons as validated through the feedback and behaviours.

Epistemic DPs also provide a road map to enhance the artefact through additional design features by carefully analysing the improvements in each epistemic dimension. For example, in future design of *Service-Symphony,* we could incorporate self-assessment modules to facilitate

introspection, add a common terminology list to promote common knowledge, and include additional practices to broaden diversity.

The evaluation followed methodical triangulation approach through surveys and web analytics. The survey responses (n=40) showed that 90% of the respondents agreed that *Service-Symphony* was relevant to them. The relevance question is considered as an indicator of introspection centricity, as a relevant knowledge source enables introspection. 98% of the users agreed the knowledge was well distributed within the ITSM domain, which is an indicator of knowledge diversity. The Web analytics indicators supported the conclusion that the *Service-Symphony* design is aligned with the Epistemic DPs.

One of the limitations of this research is not evaluating the reusability aspects of the DPs with designers of future INDICO. If the DPs are not validated by practitioners, there is a risk that the DPs may not be useful in the practice (Cronholm & Göbel 2018; Iivari, Hansen & Haj-Bolouri 2018; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). The researchers acknowledge this risk.

Another limitation is validating with users whether they had used *Service-Symphony* to improve or innovate processes in their organisation. In the organisational setting, there could be more targeted analysis and interventions possible. For example, we could identify specific power user groups, design strategies to improve usage and invite the power users to collaborate to improve and innovate processes. This research will consider an organisational case study as part of future research.

This research has broader implications to the research and practice communities, as it serves as an exemplar case study in applying DSR using DPs to support both the design, development, and evaluation of digital commons that are intended to foster innovation.

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CHAPTER 6 EVALUATION OF ITSM DIGITAL COMMONS BY STUDENTS

Publication title	Reference
'Inclusion of complementary industry knowledge in IT service management curriculum-a case study' (Ramakrishnan, Shrestha & Soar 2020)	Ramakrishnan, M, Shrestha, A & Soar, J 2020, 'Inclusion of Complementary Industry Knowledge in IT Service Management Curriculum-A Case Study', *23rd Pacific Asia Conference on Information Systems (PACIS 2020),Dubai, United Arab Emirates*, p. 124, <https://aisel.aisnet.org/pacis2020/124>, https://aisel.aisnet.org/pacis2020/124.

Introduction

Evaluation is one of the important aspects of DSR research. This chapter describes an approach to evaluate student feedback using methodical triangulation of ITSM knowledge commons. The evaluation includes 14 survey responses and written feedback of 79 students who have enrolled in the ITSM course at the University of Southern Queensland. The results suggest that ITSM knowledge commons met the needs of the students and identified the improvement areas. The thesis compass of this chapter is shown in Figure 6-1.

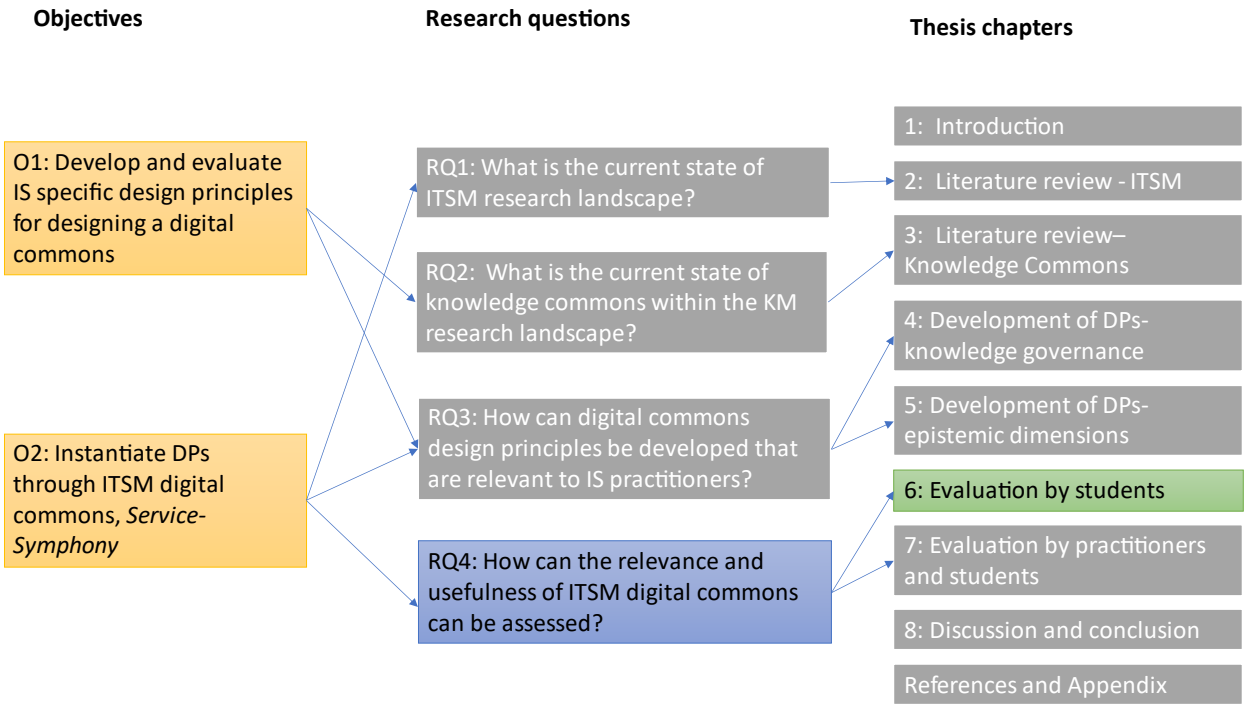

FIGURE 6-1 THESIS COMPASS - CHAPTER 6

6-22-2020

Inclusion of Complementary Industry Knowledge in IT Service Management Curriculum – A Case Study

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CHAPTER 7 EVALUATION OF ITSM DIGITAL COMMONS BY PRACTITIONERS AND STUDENTS

Publication title	Reference
'Achieving industry-aligned education through a digital commons: a case study' (Ramakrishnan et al. 2022)	Ramakrishnan, M, Gregor, S, Shrestha, A & Soar, J 2022, 'Achieving Industry-aligned Education through Digital-Commons: A Case Study', *Journal of Computer Information Systems*, pp. 1-15, https://doi.org/10.1080/08874417.2022.2115955

Introduction

This chapter provides an overview of the evaluation by students and practitioners. Aligning student skills with industry practices in the current fast-changing digital economy is one of the many challenges faced by higher education institutions. In this chapter, a novel approach is presented in which a digital commons was built to serve as a bridge between emerging industry practices and academic curricula. In a digital commons, knowledge is created and shared online. This case study describes the motivation for, and the design, development, and evaluation of an industry practice digital commons (IPDC) to assist students in developing relevant industry knowledge. The target students were pursuing a course on IT Governance and Service Management (IGSM) at an Australian university. The development of the digital artefact followed the design science research (DSR) paradigm. Feedback from 78 students and 26 practitioners and the visitor analytics totaling 122360 user sessions indicated that both student and practitioner communities considered the IPDC to be valuable. The thesis compass of this chapter is shown in Figure 7-1 .

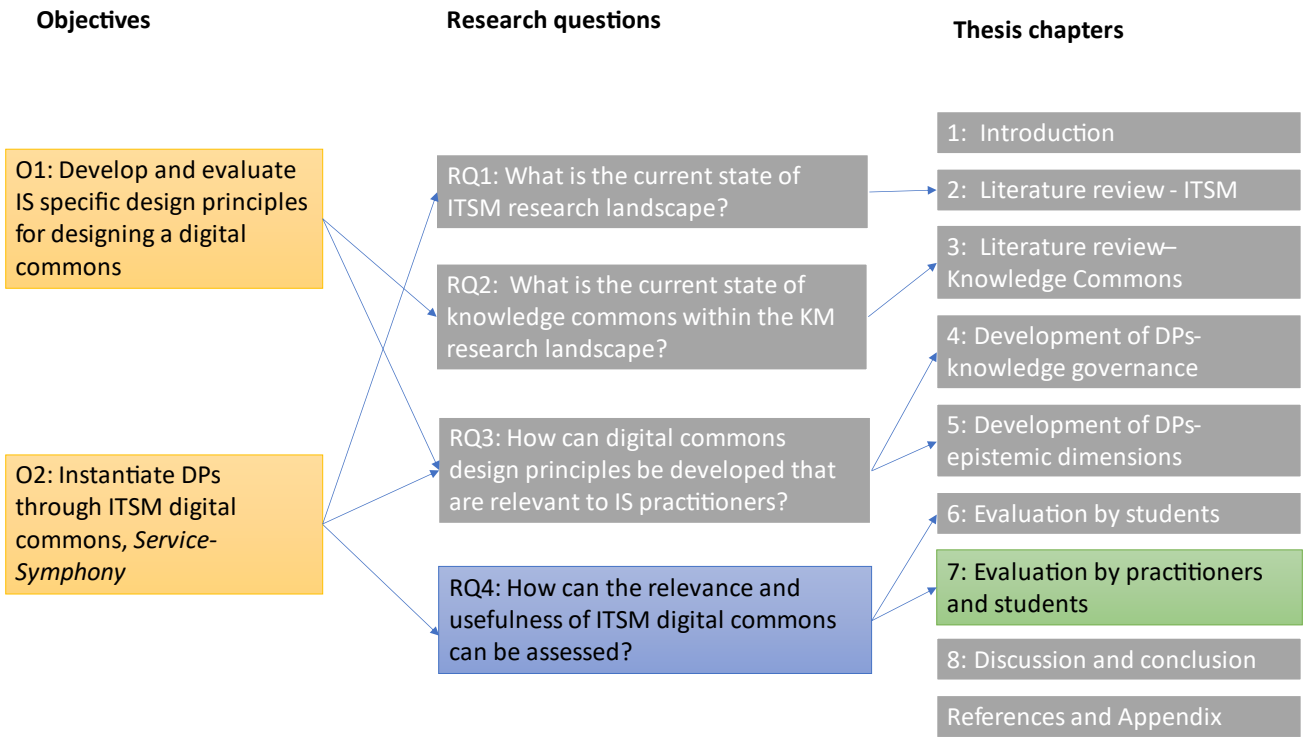

FIGURE 7-1 THESIS COMPASS - CHAPTER 7

CHAPTER 8 DISCUSSION AND CONCLUSION

This research commenced with the problem statement, "Within the ITSM Knowledge ecosystem, no single platform exists that provides a holistic, current view of knowledge" and identified two objectives:

> Objective 1. Develop and evaluate IS specific DPs for designing a digital commons; and
>
> Objective 2. Instantiate DPs through ITSM digital commons – Service-Symphony.

The objectives translated into four research questions:

RQ1: What is the current state of ITSM research landscape that deals with multi-process complexity?

RQ2: What is the current state of knowledge commons within the KM research landscape?

RQ3: *How can digital commons DPs be developed that are relevant to IS practitioners?*

RQ4: How can the relevance and usefulness of ITSM digital commons be assessed?

This discussion chapter reflects on how the research addressed each research question.

8.1 DISCUSSION ON RQ1: RESEARCH LANDSCAPE OF ITSM MULTI-PROCESS COMPLEXITY

This research explored the literature to identify research papers that studied the ITSM, governance and continual improvement process frameworks and found 654 papers that satisfied the search criteria. The paper titles and abstracts were screened further and identified 67 papers that discussed multiple process frameworks. Duplicate papers and papers

that discussed only one framework were rejected. These 67 papers were studied, and 41 papers were selected for inclusion in the literature review. The extant research has focussed on one of two approaches: (a) mapping of similar reference models; and (b) integration/harmonisation of models based on a formal ontology. The mapping solution involves documenting the relationships and commonalities of processes across similar frameworks (Ehsan et al. 2010; Karkoskova & Feuerlicht 2015; Ekanata & Girsang 2017). The ontology-based integration formalises the mapping by developing an ontology and building a unified model (Pardo et al. 2012a; Pardo et al. 2013; Pardo et al. 2014).

Both integration and mapping solution approaches assume implicitly that the organisations know the frameworks that are relevant to their businesses. In a dynamic ecosystem, the organisations may not be aware of the existence of emerging frameworks (Pricope & Lichter 2011). In addition, Mejia, Muñoz and Muñoz (2016) point out that one of the challenges of multi-model integration is managing a large amount of information and decision-making, thereby limiting scalability. Further, the models are not designed to evolve together with changes in the environment as each model evolves independently without consideration of other models

The literature survey validated the observations and discussions with the industry practitioners who supported the development of a public-facing, purpose-built ITSM knowledge commons to address the multi-process complexity. This research conceptualised a knowledge repository like Wikipedia and the extant researchers analysed Wikipedia through the lens of knowledge commons theory (Viégas, Wattenberg & McKeon 2007; Forte, Larco & Bruckman 2009; Safner 2016) which served as a logical starting point. The application was limited to verifying whether the commons DPs are applicable and no further analysis was performed to make the DPs useful to IS practitioners. This research knowledge gap led

to conducting a SLR to explore the current state of research on knowledge commons.

8.2 DISCUSSION ON RQ2: UNDERSTANDING THE CURRENT STATE OF RESEARCH ON KNOWLEDGE COMMONS

To understand the current state of research on knowledge commons, a SLR was conducted that identified 44 relevant research papers which discussed the commons published in 23 high-impact KM journals. The research found that the application of commons in KM literature covers diverse areas including Intellectual Property, Knowledge Cities and Industrial Commons. Within the SLR, this research focused on innovation-centricity, that is, the knowledge that underpins or leads to innovation.

It is observed that the 'tragedy of commons' argument by Hardin (1968) was discussed in 24 papers. It is important to explain the theory progression of commons in more detail to point out the limitations in the existing KM papers. The tragedy of commons is classified as one of the first-generation collective action theories. Collective action theory deals with a group of individuals, a common interest among them, and potential conflict between the common interest and each individual's interest (Ostrom & Ahn 2009). The first-generation theories assume that individuals are not capable of achieving joint benefits when left to themselves. First-generation theorists assume the image of atomised, selfish, and fully rational individuals (Ostrom & Ahn 2009).

On the other hand, the second-generation theorists acknowledge there are multiple types of individuals who exist in an ecosystem, including the ones who are non-selfish and willing to cooperate. Professor Elinor Ostrom is a notable scholar among the second-generation collective action theorists and was recognised for her work on commons (Wall 2014). The body of work Ostrom has produced was acknowledged as one that "contributes to some of the most important questions of the twenty-first century…." (Wall 2014, p. 3).

Ostrom's work was chosen as the preferred management theory because:

- Ostrom's work is acknowledged as a credible theory by economists and policy makers;
- Ostrom had developed a set of DPs for commons; and
- the DPs were applied in IS domain to analyse Wikipedia.

Though the DPs developed by Ostrom were applied to Wikipedia, this research found that further work needed to be done to make it relevant to IS practitioners. Some of the initial gaps found are:

- the DPs used terminology that was specific to economists and IS practitioners could not readily relate to the DPs; and
- the DPs were used for commons that used natural resources.

There are fundamental differences between natural resources and knowledge.

This opportunity led to the third research question.

8.3 DISCUSSION ON RQ3: HOW CAN DIGITAL COMMONS DPS BE DEVELOPED THAT ARE RELEVANT TO IS PRACTITIONERS?

Multiple aspects needed to be considered to answer this research question and the following dimensions were considered to address it:

- Research paradigm
- Research steps
- Management theory
- Process of deriving the IS-specific theory that encompasses
    - Meta-requirements
    - DPs
- Evaluation of the DPs

This research followed the DSR paradigm (Hevner et al. 2004; Gregor & Hevner 2013a; Baskerville et al. 2018). On reflection, choosing DSR was the right choice as this research contributed to both the practice, by

building ITSM knowledge commons, and design theory, through the development of IS-specific DPs and meta-requirements.

This research followed broadly a six-steps approach (Peffers et al. 2007)used widely in DSR research with some adaptations. The artefact development and DPs refinement were carried out in parallel in an iterative manner, that is, IS development feeding into the refinement of DPs and the DPs driving the IS development features. The development was carried out in fortnightly sprints that followed a demonstration to an expert panel. As Service-Symphony was targeted at the practitioners and the students, evaluation was done by the practitioners and students. The communication was done through industry presentations and academic paper publications.

For guidance in designing and developing Service-Symphony, this research reviewed the management and IS literature. The commons theory that was developed by Elinor Ostrom (Ostrom 1990; Ostrom et al. 1994; Ostrom 2008) was found to be a good fit as it was a credible management theory and has been applied to comparable knowledge platforms such as Wikipedia. IS researchers have applied Ostrom's DPs to study the success of the online knowledge collaboration platform. The extant research was limited to examining whether Ostrom's commons DPs could be observed in IS platforms once constructed. The extant research approach would not necessarily reveal additional design principles that may have been introduced by designers. The extant research used the concepts and terminology from Ostrom's commons theory without any modification that would assist IS practitioners to embrace the design principles. These limitations were addressed by systematically analysing the characteristics of knowledge to propose additional design principles that are not covered in Ostrom's natural commons design principles. IS-specific DPs were applied to build Service-Symphony and the DPs were validated by IS practitioners.

This research developed two categories of DPs:

1. DPs for Knowledge Governance; and
2. DPs for epistemic dimensions.

The DPs for knowledge governance were developed first and the development was commenced by deriving the meta-requirements which are essential components of a design theory (Walls, Widmeyer & El Sawy 1992; Gregor & Jones 2007). This research formed an expert panel to get the meta-requirements and guide the development. The research execution was aligned to Agile development. For capturing the meta-requirements, 'user stories' were elicited and grouped to form meta-requirements.

The derivation of IS-specific DPs from natural commons DPs followed a systematic approach. In the first step, this research compared the knowledge commons and natural commons and identified the attributes that are different. Based on the differences, the natural commons DPs were analysed to tailor them to suit knowledge commons. In that process, the terminology was enhanced to suit IS professionals and the IS specific DPs, the PEKC DPs, were applied to ITSM knowledge commons.

If reusability is not evaluated by practitioners, there is a risk that the DPs are not useful in the practice (Cronholm & Göbel 2018; Iivari, Rotvit Perlt Hansen & Haj-Bolouri 2021). To mitigate this risk, Iivari, Rotvit Perlt Hansen and Haj-Bolouri (2021) proposed a revaluation framework comprising the following five criteria: (1) accessibility, (2) importance, (3) novelty and insightfulness, (4) actability and guidance and (5) effectiveness.

This research employed the focus group (FG) comprising solution five IS architects to conduct the DPs evaluation. All the participants agreed that the DPs are easy to understand and address an important real-world problem. All except one participant agreed that they got new insights

from the DPs. They all agreed also that the additional DPs on providing incentives, managing visibility and trust were important considerations that were sometimes overlooked.

The second category of DPs was developed based on the epistemic dimensions of self-knowledge, common knowledge and distributed knowledge. Three DPs were developed addressing 1) Introspection-centricity, 2) Common knowledge centricity, and 3) Knowledge diversity. The DPs were applied to Service-Symphony.

The evaluation followed the methodical triangulation approach through surveys and web analytics. The survey responses (n=40) showed that 90% of the respondents agreed that Service-Symphony was relevant to them. The relevance question is considered an indicator of introspection centricity, as a relevant knowledge source enables introspection. Ninety-eight percent of the users agreed the knowledge was well-distributed within the ITSM domain, which is an indicator of knowledge diversity. The Web analytics indicators supported the conclusion that the Service-Symphony design is aligned with the Epistemic DPs.

8.4 DISCUSSION ON RQ4: HOW CAN THE RELEVANCE AND USEFULNESS OF ITSM KNOWLEDGE COMMONS BE ASSESSED?

DSR advocates the rigorous evaluation of artefacts (Peffers et al. 2012; Venable, Pries-Heje & Baskerville 2016). Venable, Pries-Heje and Baskerville (2016) proposed a Framework for Evaluation in Design Science Research (FEDS). This research's evaluation strategy followed the 'Human Risk and Effectiveness' path as the major design risk of the IPDC is social- or user-oriented. The human risk and effectiveness path is ideal when it is feasible and cost-effective to evaluate the artefact with actual users.

As the target community included students and practitioners, this research viewed the introduction of Service-Symphony in the academic curriculum through the lens of connectivism learning theory (Siemens

2004; Goldie 2016; Utecht & Keller 2019). Connectivism learning theory can be characterised as a network theory of knowledge and learning with an emphasis on the use of digital technology (Downes 2019). Taking inspiration from connectivism learning theory and knowledge commons theory (Hess & Ostrom 2007; Frischmann, Madison & Strandburg 2014), this research questioned whether Service-Symphony shared between industry practitioners and students could help the students to continually learn contemporary industry practices.

Service-Symphony was evaluated using a combination of formative and summative evaluations. The formative evaluation was conducted by obtaining feedback from the expert panel throughout the development nd the summative evaluation was done by the practitioners and students. The survey indicated that the practitioners had some reservations about trusting Service-Symphon*y*. The subsequent recognition by ITSMF Australia, through the Business Innovation Award in 2019 and the positive audience access trend in Google analytics, suggest that the practitioners' concerns were addressed. The students used Service-Symphony as part of the academic assignment and were quite positive about the Service-Symphony. The students indicated that they would like to have more interactive and visually engaging content.

8.5 CONTRIBUTIONS TO SOCIETY, THEORY, AND PRACTICE

This research addresses the development of digital commons which is one of the important class of solutions. The world witnessed humanity coming together during the Covid pandemic and during the pandemic, there was a heightened need to transfer crucial, trusted knowledge from the technologically advanced countries to the nations that needed them to combat the pandemic. The digital commons played a pivotal role in addressing this knowledge transfer.

The design of digital commons is elusive to IS and management practitioners with no DPs that clearly guide the development. This

research will help the practitioners to consider the knowledge governance aspects and epistemic dimensions while designing a digital commons. The DPs derived as part of this research are expected to provide prescriptive guidance to practitioners.

This research contributed to the ITSM professional practice and academic practice by developing the purpose-built ITSM digital commons. The ITSM digital commons, Service-Symphony, is a public-facing portal that can be accessed by practitioners all over the globe and is open to all universities. Service-Symphony was used by the global community from its launch in February 2019 with over 122,000 user sessions as of May 2022.

8.6 LIMITATIONS

This research acknowledges the following limitations. The case study presented in this research was piloted in only one course (ITSM) at the parent university. There are opportunities to expand ITSM knowledge commons to other universities to get a diverse and rich set of student feedback.

The innovation-centric aspect of the knowledge has not been validated directly within an organisational context. This limitation would be addressed effectively by extending the case study to a range of organisations to provide further insights.

Similarly, the reusability evaluation of the knowledge governance DPs was limited to evaluation by IS Architects within one organisation. Inviting feedback from IS Architects across diverse organisations will be considered as part of future research.

The research evaluated epistemic DPs indirectly through the evaluation of Service-Symphony through Google Analytics and user feedback. The reusability evaluation of epistemic DPs by practitioners is not addressed within this research. This research established the use of Google Analytics to evaluate the performance of INDICO. There are opportunities to

explore further behaviour analytics to understand the user behaviour. The content of Service-Symphony is currently managed by me, the PhD student. Though the expert panel guided the development, for long-term sustainability there should be a better governance framework comprising industry and academics. For example, the establishment of a user group comprising industry practitioners, researchers, students, and professional bodies capable of keeping track of the industry advances and updating the knowledge would ensure long-term sustainability of Service-Symphony.

8.7 FUTURE VISION OF ITSM KNOWLEDGE COMMONS

I have an ambitious vision for future research from both theoretical and practice perspectives. The research area, innovation-centric knowledge commons, has further scope for expansion beyond ITSM practice. IT Governance will be one of the core focus areas in the future. Collaboration with professional bodies such as ISACA will be explored to enhance the value of Service-Symphony.

From the IS theory perspective, the vision is to expand and refine the DPs for innovation-centric knowledge. Linking the theory to innovation commons (Allen & Potts 2016; Potts 2019) is one of the interesting opportunities I am planning to explore.

From the practice perspective, the vision is to expand in both the academic community and practice community. Enhancing the cyber-security of Service-Symphony is one of the considerations as there have been recent cyber-attacks in the Australian businesses. Though the attackers seem to be targeting high profile organisations, we cannot rule out the risk of cyber-attacks to any online portal. Currently Service-Symphony is managing the cyber threat by installing Secure Sockets Layer (SSL) certificate and restricting the access to interactive comments only to LinkedIn members. A security feature automatically blocks any

user who tries to access without credentials. In future, a cyber-security audit will be conducted to address any vulnerabilities.

The DPs and the instantiated ITSM digital commons, Service-Symphony, provide a solid foundation to instantiate to other domains, including non-IS subject areas Within IS discipline, it is possible to use Service-Symphony as a complementary teaching resource in related subjects including but not limited to project management, enterprise architecture, IT governance, quality management, operational excellence, DevOps and continual improvement. This research explores opportunities to expand the use of Service-Symphony to other universities.

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CHAPTER 10APPENDICES

APPENIDX A - ARTEFACT DESCRIPTION

10.1 TECHNICAL ARCHITECTURE

Service-Symphony is developed as a Green-field application. The application development used a configurable platform approach that considerably eases the application development process (Rodas-Silva et al. 2019). The technical architecture is shown in Figure 0-1

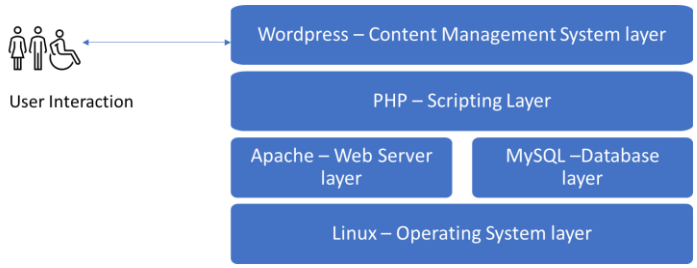


FIGURE 0-1 ITSM DIGITAL COMMONS - TECHNICAL ARCHITECTURE

This research used WordPress as the Content Management System (CMS). WordPress is one of the widely used and reliable open-source CMS (O'Neill 2017; Cabot 2018). The CMS was supported by multiple technologies, known as LAMP stack. The traditional LAMP stack is consistent with Linux as the Operating System, Apache web-server, MySQL as the relational database, and PHP as the programming language (Louridas 2016). The LAMP is an abbreviation of "Linux, Apache, MySQL and PHP." The modern LAMP now provides broader stack options (Louridas 2016).

Selection of WordPress and the supporting architecture proved to be useful in rapid prototyping. WordPress allows configuration in three levels – 'themes' that determine the overall 'look and feel' of the repository, 'plug-ins' that offer specific functionalities, and custom coding to customise the themes and plugins.

This research used a simple theme, which enabled us to display the various processes, tools and provided the search function. As development progressed, the expert panel members provided feedback to include specific features. Such requests could be implemented within a fortnight by using the right plugins. Besides, the plugins enabled the researcher to experiment with features, for example, a language translation feature of repository based on feedback. This feature was easily deactivated when it was found the translation quality need to be improved.

Integration with the professional networking platform, LinkedIn was also achieved through the configuration of plugin. This integration is one of the ways to ensure that the feedback from the participants can be verified.

One of the limitations of technical architecture is the consideration for cybersecurity. This research relied on the hosting providers' security and WordPress platforms' native prevention capabilities. Though there have

no breaches so far, the researchers are witnessing failed attempts. This research needs to investigate strategies to strengthen the cybersecurity.

10.2 INFORMATION ARCHITECTURE

Information Architecture is a combination of organising, labelling, implementing navigation schemes and evaluating information spaces (Dillon 2002; Rosenfeld & Morville 2002).

While putting together the information in Service-Symphony, this research considered the following search goals. The user should be able to:

- search across all frameworks, lifecycle, processes, tools, skills
- search within specific granularity (for example, within process level)
- search within a specific framework (for example, within ITIL v3)
- search within a specific framework and granularity (for example, within ITIL 4, process/practices)
- browse and access any specific process area directly without the need for searching
- utilise side-by-side comparison of specific frameworks

WordPress content can be organised as pages, posts, categories and tags (O'Neill 2017). The pages serve as a high-level container, for example the landing page of any website. Service-Symphony uses the landing page to welcome the visitor and present an overview of the process frameworks and tools. Each knowledge article within Service-Symphon*y* is managed as a post. The WordPress posts were managed in hierarchical fashion using the 'categories'. The categories were used to build the hierarchy tree of Framework -> Lifecycle -> Process.

One of the objectives of Service-Symphony is to enable the users to understand the overlap between the frameworks. For example, a user

might wish to understand how the process 'change management' is addressed in ITIL v3, ITIL 4 and COBIT 2019. To facilitate this comparison, this research used the 'tag' feature of WordPress. Each post is tagged to the corresponding framework.

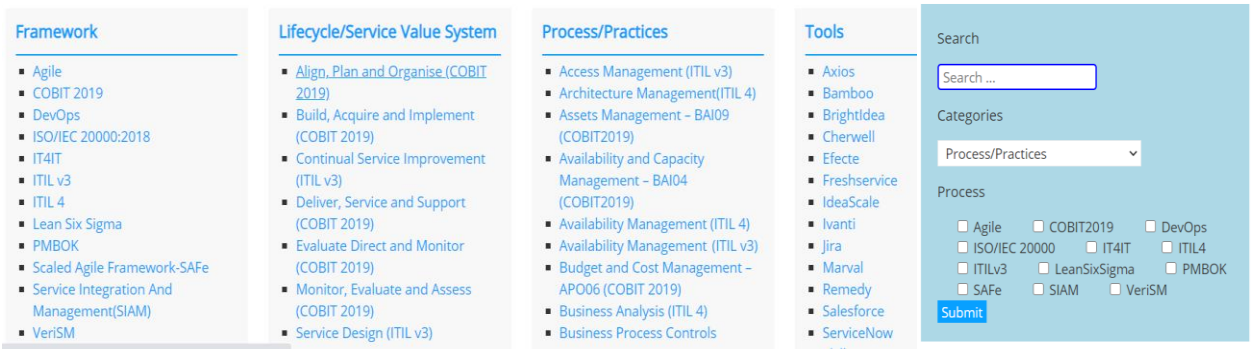


FIGURE 0-2 INFORMATION ORGANISATION IN ITSM KNOWLEDGE REPOSITORY

The implementation of hierarchy and targeted search is shown in Figure 0-2.

A visitor can get a helicopter view of the information by browsing the landing page of Service-Symphony. If they want to access a specific process framework, they can do so by directly clicking the relevant framework. The framework has further hierarchical structures that are organised as lifecycle stages and process/practices. Each framework may have their own specific terms to describe the hierarchy.

The search box on the right side of Figure 0-2 shows that the user can search within a specific framework, or group of frameworks. For example, the user might search change management to get a view of how different frameworks address the change management process.

Each process framework is shown how it fits within the context of COBIT 2019 and ITIL 4 frameworks as shown in Figure 0-3. For example, if a practitioner or student wants to know how Agile fits within the lifecycle, they can understand that Agile is part of Obtain/Build activity as per ITIL 4 and belongs to the 'Build, Acquire and Implement' domain of COBIT 2019.

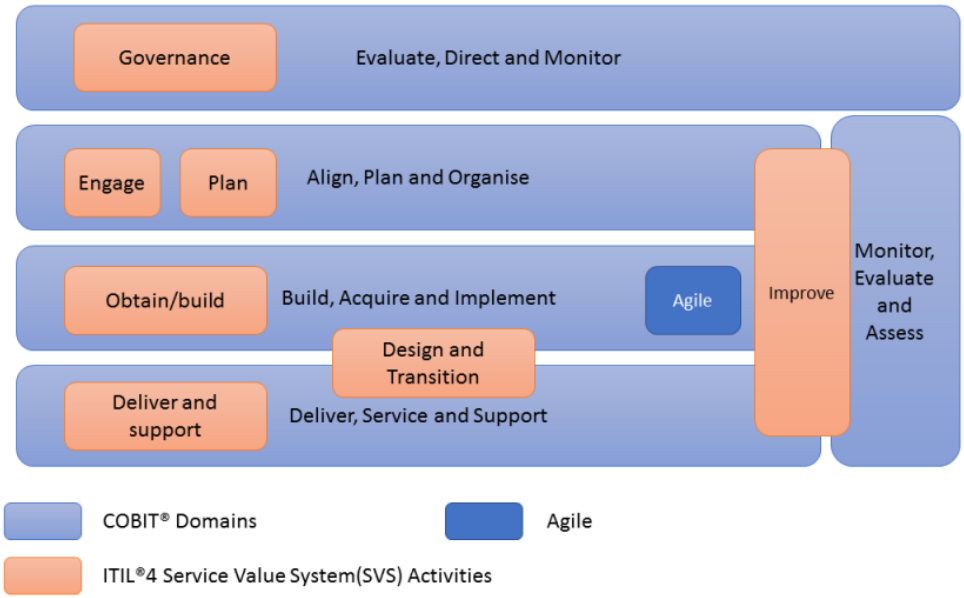


FIGURE 0-3 ITSM PROCESS ARCHITECTURE

The following screenshots provide the organisation of knowledge articles within the process areas.

PMBOK

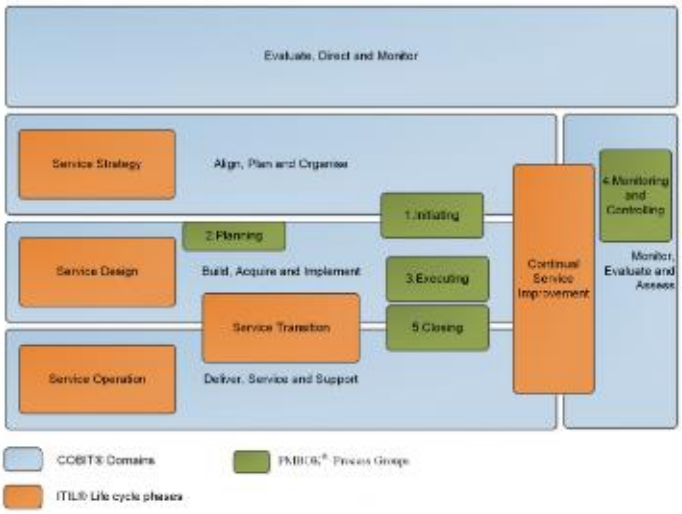
Posted on January 18, 2020 | By admin

PMBOK is one of the widely used Project Management methodology. PMBOK is the abbreviation of Project Management Body of Knowledge.

A Guide to the Project Management Body of Knowledge (PMBOK® Guide) is periodically published by Project Management Institute (PMI). The latest edition, PMBOK® Guide 6th edition, published in September 2017 includes the Agile Practice Guide.

Context diagram

The context diagram shows the overlap of PMBOK process groups and the relationship with COBIT and ITIL v3. The initiating process group overlaps with the Align, Plan and Organise domain to show that the project can be initiated to align with the strategic direction of the business. The Closing process group overlaps with "deliver, service and support" domain to ensure that the project handover to operations need to be considered.



Summary ratings

Please refer the Rating Criteria.

Longevity	★★★★★ (5 / 5)
Industry Adoption	★★★★★ (5 / 5)
Tool Support	★★★★★ (5 / 5)
Training Support	★★★★★ (5 / 5)
Assessment Support	★★★★★ (5 / 5)

Project Management Certification is first introduced in 1984 and since then it has been widely accepted in the professional community (https://www.pmi.org/learning/library/project-management-certification-history-development-4941). The Project Management profession is supported by mature technology tools and training.

For assessment, the businesses can use OPM3 model. OPM3 (Organisational Project Management Maturity Model) is a body of knowledge about project management best practices, and this body of knowledge enables organisations to improve their current organisational project management maturity. The three interlocking elements of OPM3 (knowledge, assessment and improvement) enable organisations to assess their current state of project management maturity and then to map an improvement path to a higher level of maturity. Model components include best practices, capabilities, outcomes and key performance indicators.

Filter

Search

Search ...

Categories

Framework

Process

☐ Agile ☐ COBIT2019 ☐ DevOps
☐ ISO/IEC 20000 ☐ IT4IT ☐ ITIL4
☐ ITILv3 ☐ LeanSixSigma ☐ PMBOK
☐ SAFe ☐ SIAM ☐ VeriSM

Submit

FIGURE 0-4 SCREENSHOT - PMBOK

ITIL 4

Posted on March 11, 2019 | By admin

ITIL reference framework, training and certification and tools have been used by IT Service Management practitioners around 30 years. ITIL 4 is the latest revision of ITIL framework released in 2019. ITIL 4 has revisited practices in the wider context of customer experience, value streams, and digital transformation, as well as embracing new ways of working, such as Lean, Agile, and DevOps.

The life cycle phases (strategy, design, transition, operation) in ITIL v3 are not used in ITIL 4

ITIL 4 introduces Service Value System (SVS) comprising activities and practices. The ITIL SVS describes how all the components and activities of the organization work together as a system to enable value creation. Each organization's SVS has interfaces with other organizations, forming an ecosystem that can in turn facilitate value for those organizations, their customers, and other stakeholders.

The six value chain activities are:

- plan
- improve
- engage
- design and transition
- obtain/build
- deliver and support.

These activities represent the steps an organization takes in the creation of value.

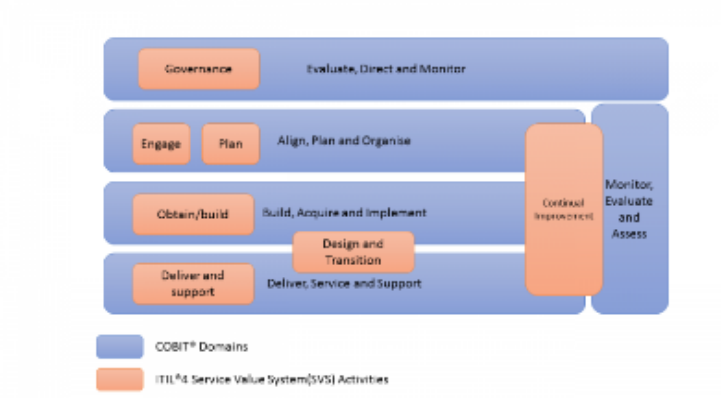
A practice is a set of organizational resources designed for performing work or accomplishing an objective. These resources are grouped into the four dimensions of service management. The dimensions are:

- organizations and people
- information and technology
- partners and suppliers
- value streams and processes

Please note the following changes in the concepts and terminology between ITIL v3 and ITIL 4.

ITIL v3	ITIL 4
Life cycle approach	Value stream approach
Service Excellence: Provider deliver services to the consumer organisation by providing efficient services	Value co-creation: Provider co-creates value by collaborating with the consumer organisation
Life cycle phase contains processes	Value Stream activities contain practices. Practices have four dimensions: organizations and peopleinformation and technologypartners and suppliers value streams and processes
One to one relationship between process and life cycle phases (though relationship with other processes are defined)	A practice is often grouped under many Value Stream activities
Often interpreted as linear model	promotes iterative, agile approach
5 life cycle phases, 26 processes	6 Service Value Stream Activities, 34 practices General Management practices: 14 Service Management: 17 Technical management: 3

Context diagram



Filter

Search

Search ...

Categories

Framework

Process

Agile COBIT2019 DevOps
ISO/IEC 20000 IT4IT ITIL4
ITILv3 LeanSixSigma PMBOK
SAFe SIAM VeriSM

Submit

FIGURE 0-5 SCREENSHOT -ITIL4

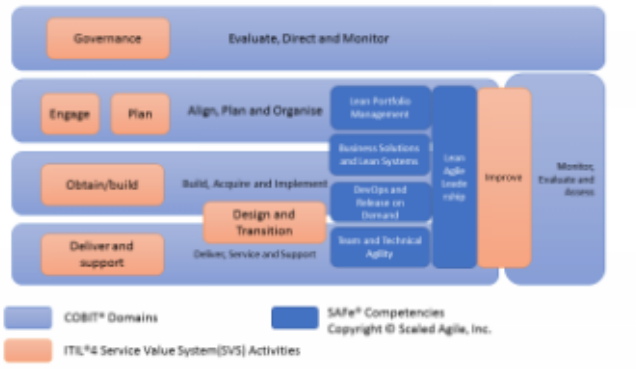
Scaled Agile Framework-SAFe

Posted on November 10, 2018 | By admin

SAFe® (Copyright © Scaled Agile, Inc) is a body of knowledge of principles, practices and competencies for Lean, Agile and DevOps. The framework is built on the foundations of Agile and provides a structured approach for scaling up the practices across the enterprise.

Context diagram

SAFe spans across all life cycle stages of ITIL and corresponding COBIT domains. As SAFe principles and practices are leverage from Lean, Agile, Enterprise Architecture, DevOps practices, the emphasis is on Agility. The waterfall and control practices of ITIL, COBIT are not emphasised. SAFe defines five competencies and four configurations. The configurations provide a clear blueprint for scalability which was lacking in other Agile frameworks.



Summary ratings:

Please refer the Rating Criteria.

SAFe is released on 2011 and has gone periodic revisions. The industry adoption among large enterprises, especially in the USA is cited. As the scope of SAFe is quite broad, there are no dedicated tools to support. However, the tools that support Agile can be leveraged. It will be good to get an integrated tool that supports the full spectrum of SAFe practices including Lean Budgets, Value Streams, Enterprise Architecture, Release Train Management etc.

SAFe provides very good training support including certification. Accredited trainers are available in many countries.

SAFe is not intended for a formal assessment.

Longevity	★★★★★ (4 / 5)
Industry Adoption	★★★★★ (3 / 5)
Tool Support	★★★★★ (2 / 5)
Training Support	★★★★★ (5 / 5)
Assessment Support	★★★★★ (0 / 5)

Competencies and Configurations

SAFe is organised based on competencies and "configurations". There are five competencies.

Lean-Agile Leadership

The Lean-Agile Leadership competency describes how Lean-Agile Leaders drive and sustain organizational change and operational excellence by empowering individuals and teams to reach their highest potential. They do this by learning, exhibiting, teaching, and coaching SAFe's Lean-Agile mindset, values, principles, and practices.

Filter

Search

Search ...

Categories

Framework

Process

☐ Agile ☐ COBIT2019 ☐ DevOps
☐ ISO/IEC 20000 ☐ IT4IT ☐ ITIL4
☐ ITILv3 ☐ LeanSixSigma ☐ PMBOK
☐ SAFe ☐ SIAM ☐ VeriSM

Submit

FIGURE 0-6 SCREENSHOT -SCALED AGILE FRAMEWORK

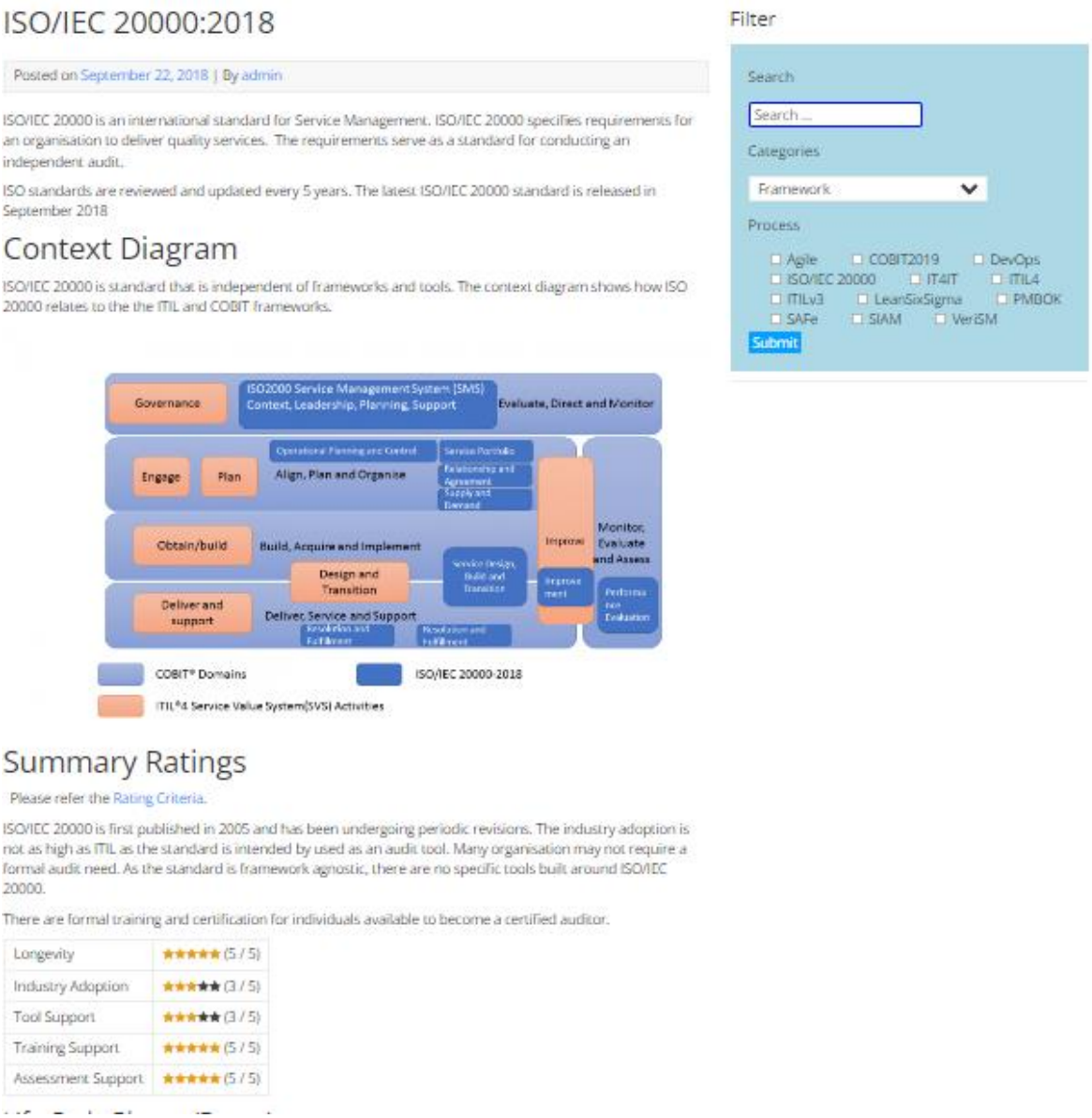


FIGURE 0-7 SCREENSHOT-ISO/IEC 20000:2018

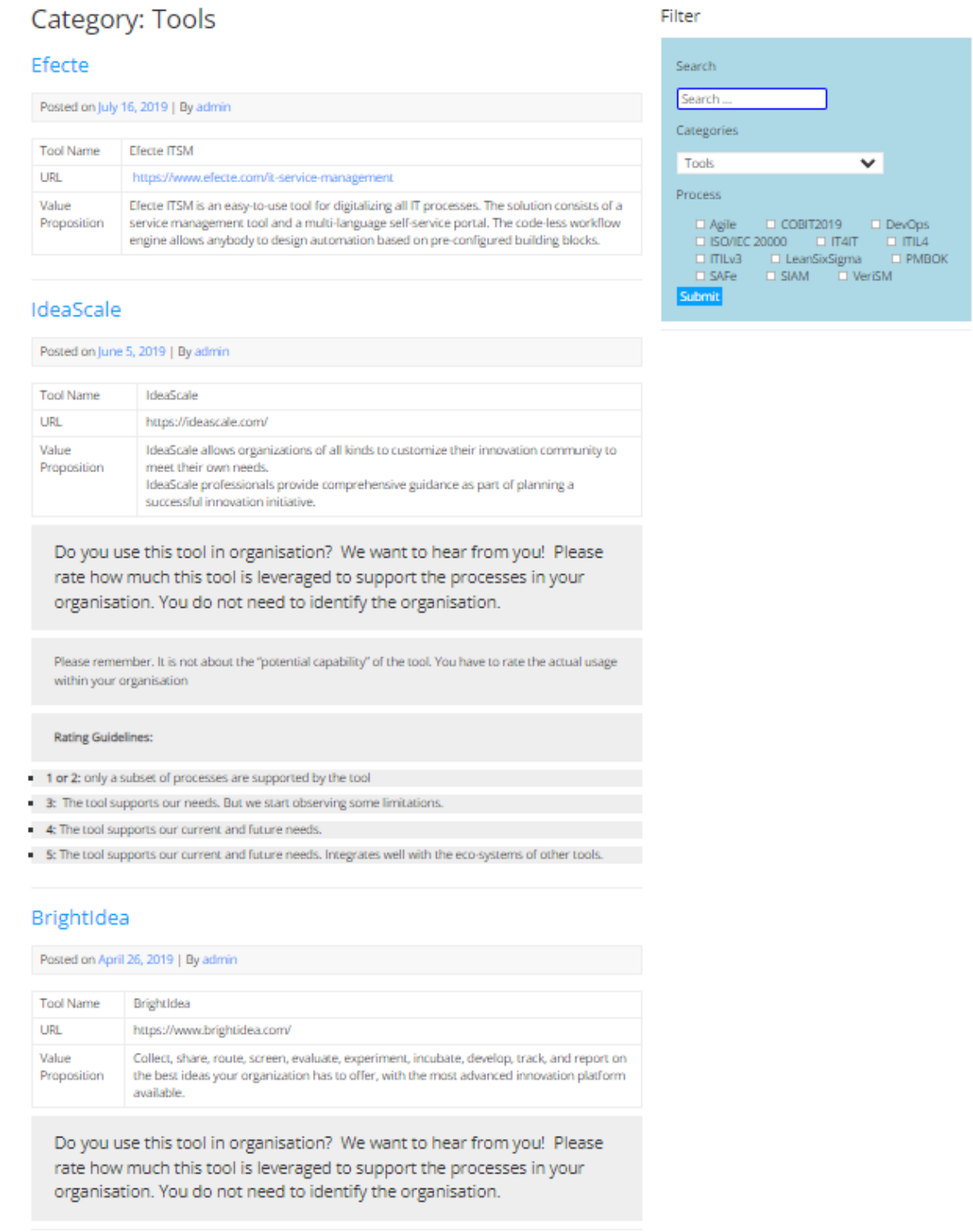


FIGURE 0-8 SCREENSHOT - CATEGORY-TOOLS

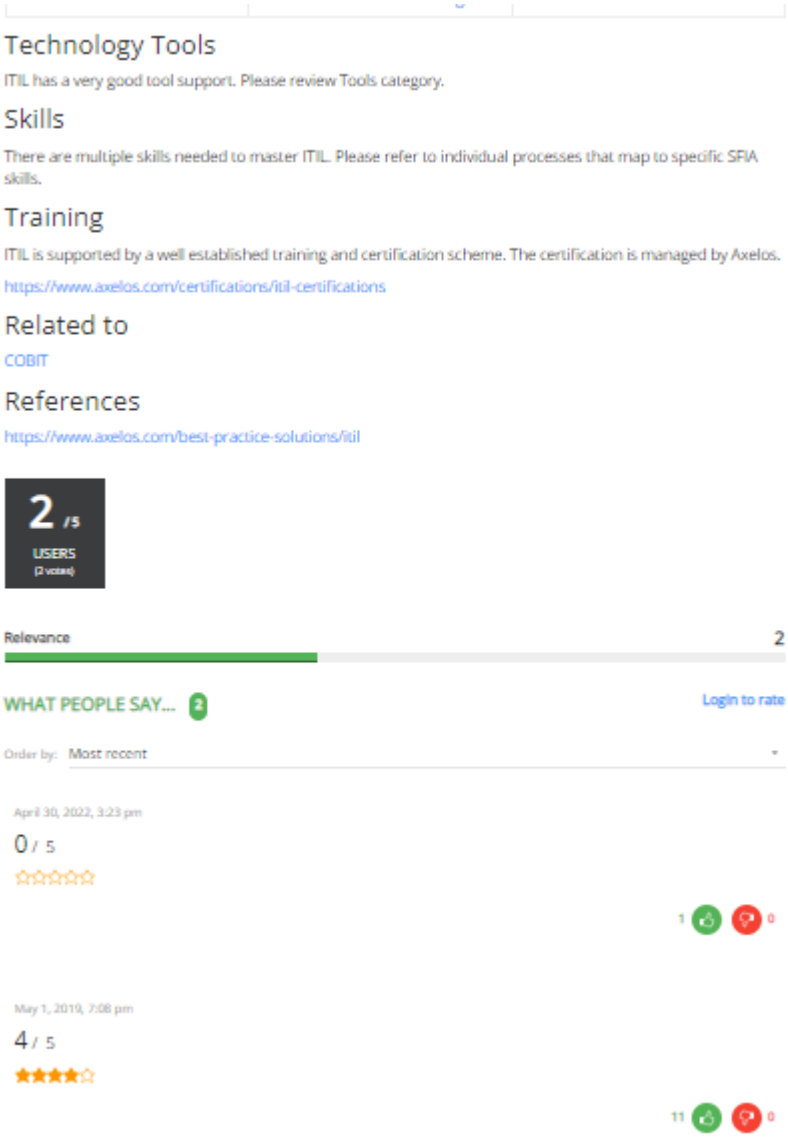


FIGURE 0-9 SCREENSHOT - FEEDBACK MECHANISM

APPENDIX B - SURVEY QUESTIONS

Dimensions	**Net Promoter Score Question**	**Response format**
Net Promoter Score	Do you recommend *Service-Symphony* to your friends or colleagues?	Numerical scale [0 to 10]
Design dimensions based on ISO/IEC 25000	**Design dimension questions**	**Response format**
Relevance	The IPDC is useful and relevant to me	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Ease of finding	It is easy to find the relevant knowledge article	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Visual appeal	The knowledge is visually well presented	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Readability	The content is easy to read and understand	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Trust	I trust the information presented in the IPDC	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Coverage	The knowledge coverage is well distributed between multiple process reference frameworks and supporting tools	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Currency	The knowledge reflects the current state of IGSM practice	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Structure	The content is well structured	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Usability	I am able to read the contents properly on my device's screen	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)
Security	I feel comfortable and secure to browse the IPDC	Likert scale (strongly agree, agree, neutral, disagree and strongly disagree)

APPENDIX C - SUMMARY OF KEY FRAMEWORKS

10.3 ITIL 4

ITIL reference framework, training and certification and tools have been used by IT Service Management practitioners around 30 years. ITIL 4 is the latest revision of ITIL framework released in 2019. ITIL 4 has revisited practices in the wider context of customer experience, value streams, and digital transformation, as well as embracing new ways of working, such as Lean, Agile, and DevOps.
The life cycle phases (strategy, design, transition, operation) in ITIL v3 are not used in ITIL 4

ITIL 4 introduces Service Value System (SVS) comprising activities and practices. The ITIL SVS describes how all the components and activities of the organization work together as a system to enable value creation. Each organization's SVS has interfaces with other organizations, forming an ecosystem that can in turn facilitate value for those organizations, their customers, and other stakeholders.
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A practice is a set of organizational resources designed for performing work or accomplishing an objective. These resources are grouped into the four dimensions of service management. The dimensions are:

- organizations and people
- information and technology
- partners and suppliers
- value streams and processes

ITIL 4 encompasses the following practices:

TABLE 10-1 ITIL 4 PRACTICES

General management practices	Service management practices	Technical management practices
Architecture management Continual improvement Information security management Knowledge management Measurement and reporting Organizational change management Portfolio management Project management Relationship management Risk management Service financial management Strategy management Supplier management Workforce and talent management	Availability management Business analysis Capacity and performance management Change control Incident management IT asset management Monitoring and event management Problem management Release management Service catalogue management Service configuration management Service continuity management Service design Service desk Service level management Service request management Service validation and testing	Deployment management Infrastructure and platform management Software development and management

10.4 COBIT 2019

COBIT is a business framework for the governance and management of enterprise IT. Enterprise IT means all the technology and information processing the enterprise puts in place to achieve its goals, regardless of where this happens in the enterprise. Enterprise IT is not limited to the IT department of an organization but certainly includes it
COBIT 2019 is the latest version of COBIT. Some of the enhancements from the previous version of COBIT (i.e., COBIT 5) are:

- introduction of design factors. Design factors provide guidelines to organisation to tailor the guidelines to suit their needs
- introduction of focus areas.
  A focus area describes a certain governance topic, domain or issue that can be addressed by a collection of governance and management objectives and their components. Examples of focus areas include small and medium enterprises, cybersecurity, digital transformation, cloud computing, privacy, and DevOps
- Component: Components are factors that, individually and collectively, contribute to the good operations of the enterprise's governance system over IT. Components interact with each other, resulting in a holistic governance system for IT. Processes, Organisational Structures, Policies, Competencies are some of the examples of Components.
- Component can be defined at *Generic* level and a *Variant* can exist. DevOps exemplifies both a component variant and a focus area. DevOps requires specific guidance, making it a focus area. DevOps includes a number of generic governance and management objectives of the core COBIT model, along with a number of variants of development-, operational- and monitoring-related processes and organizational structures

The governance and management objectives in COBIT are grouped into five domains.

Evaluate, Direct and Monitor (EDM) domain groups the governance objectives. In this domain, the governing body evaluates strategic options, directs senior management on the chosen strategic options and monitors the achievement of the strategy.
Management objectives are grouped in four domains.

Align, Plan and Organize (APO) addresses the overall organization, strategy and supporting activities for I&T.
Build, Acquire and Implement (BAI) treats the definition, acquisition and implementation of I&T solutions and their integration in business processes.
Deliver, Service and Support (DSS) addresses the operational delivery and support of I&T services, including security.
Monitor, Evaluate and Assess (MEA) addresses performance monitoring and conformance of I&T with internal performance targets, internal control objectives and external requirement