

Leveraging Visualizations with Systems for Operational and Strategic Decision-Making

Carol E Cuthbert

Student Number: G16C8312

Thesis presented for the degree of

DOCTOR OF PHILOSOPHY

in the

Rhodes Business School

Faculty of Commerce

January 2025

Supervisors

Prof. Noel J. Pearse

Prof. Karen Bradshaw

DEDICATION

To

my husband, who has supported me throughout my academic journey.

ACKNOWLEDGEMENTS

Special thanks are due to my supervisors, Professor Noel J. Pearse and Professor Karen Bradshaw, who provided insight into the writing of this thesis. Their support significantly contributed to a fulfilling research experience. Specifically, I thank Professor Pearse for rescuing me down many rabbit holes and Professor Bradshaw for her green scribbles. I am also grateful to Professor Owen Skae for his invaluable mentoring, inspiration, and co-authorship on my first paper in a different field. I thank all my colleagues at the Rhodes Business School for their continual encouragement and support.

My family has been the most critical enabler of my achievements so far. To Glenn for cooking when I had no time or energy (and I don't cook well) and for continual support. To my sons and daughter for telling me not to give up and to my mother for encouraging me daily.

ABSTRACT

Dynamic capability-enhancing technology, Subject Matter Experts (SMEs), System Experts (SEs) in planning and forecasting, and big data used for sensemaking combine to enable knowledge-based management decisions in interdisciplinary teams, increasing competitive advantage. This research extended Contingent Resource-based Theory CRBT by focusing on visualization's role in this process.

SMEs and SEs configure assumptions, with visualizations, in an interdisciplinary team to enable planning within the context of legal practice management systems. The study employed a mixed-method sequential explanatory design. An initial quantitative component determining which types of decision-making information technology contribute to the competitiveness of a firm was undertaken. Niche systems were found to increase technological dynamic capability through their highly configurable workflow tools, which provide customization capabilities and the ability to react to a changing environment quickly.

Niche systems differentiated through process automation were found to be the aspect to focus on in a qualitative research study. A knowledge-sharing process model was developed from the literature, and this was overlaid with visualization as the new knowledge-sharing enabler. Then, a thematic qualitative study of interviews focusing on SMEs' and SEs' use of visualization in legal and financial system implementation was employed to establish the extent to which this process occurs in legal financial transformation projects. Seven subject matter experts and four system experts in legal transformation implementations were interviewed regarding using visualization to facilitate communication, verification, and process configuration during the knowledge-sharing process. The research illustrated how

(1) low code systems data, (2) people, and (3) data enable the creation, sharing, and configuration of knowledge in practice in the legal practice management context.

Recommendations for further research were made to automate refining budgeting and forecasting assumptions. This enables management to arrive at more accurate forecasts by refining assumptions and producing the resultant profit and loss reports visually in heat maps depicting variance between the forecast and actual profit and loss reports. The SMEs provide feedback, and the system cycles between multiple assumption iterations, reducing the variance and enhancing management decision-making.

Visualization was found to assist the knowledge-sharing process through (1) verification, (2) process enablement, and (3) communication for decision-making. This research highlighted the value of variance heat maps and other visualizations and workflows in making planning assumptions explicit, thereby enhancing forecasting accuracy.

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LIST OF ABBREVIATIONS

Artificial Intelligence	AI
Artificial General Intelligence	AGI
Analysis of Variance	ANOVA
Application Programming Interface	API
Big Data (Analytics) Capability	BAC
Big Data Analytics	BDA
Bidirectional Encoder presentations from Transformers	BERT
Business Intelligence	BI
Contingent Resource-based Theory	CRBT
Density-based spatial clustering applications	DBSCAN
Enterprise Cognitive Computer	ECC
Conference on Education and Information Systems, Technologies and Applications	EISTA
Frequent Pattern Growth	FPG
Generative Artificial Intelligence	GAI
In-Context Learning	ICL
Information and Communications Technology	ICT
International Institute for Informatics and Systems	IIIS
International Multi-Conference Society, Cybernetics and Informatics	IMSCI
Internet of Things	IOT
Information Systems	IS
Key Performance Indicator	KPI
Knowledge Management	KM

Knowledge-Sharing	KS
Low Code/ No Code	LCNC
Low Code Platform	LCP
Low Code System	LCS
Legal Electronic Data Exchange Standard	LEDES
Large Language Models	LLM
Machine Learning	ML
No Code	NC
Natural Language	NL
Natural Language Interfaces	NLIs
Natural Language Processing	NLP
No Structure Query Language	NoSQL
Outside Counsel Guideline	OCG
Professional Service Firm	PSF
Resource-based Theory	RBT
Reinforcement Learning from Human Feedback	RLHF
Robotic Process Automation	RPA
Human Research Ethics Committee	RU-HREC
Socialization, Externalization, Combination, Internalisation	SECI
Supervised Fined Tuning	SFT
Subject Matter Expert	SME
Systems Expert	SE
Structured Query Language	SQL
Theory of Growth of the Firm	TGF

User Interface	UI
Unified Task-Based Management System	UTBMS
World Multi-Conference on Systemics, Cybernetics, and Informatics	WMSCI

CHAPTER 1 INTRODUCTION

1.1 Background Context

Over the past three decades, information technology (IT) has infiltrated every aspect of society. Kipnis (1991) discussed the impact of technology on social behaviour and processes. It is argued that technology should be a significant variable in social psychology, given its influence on human interaction. Technology shapes interactions and influences communication patterns, relationship dynamics, and social behaviour. Research has shown that excessive use of technology tools for communication may hinder empathy, social competence, and cognitive development; however, they could also support marginalized groups (Benvenuti, Wright, Naslund, and Miers, 2023). Research has also shown that technological tools are overcoming traditional barriers to information acquisition (Antonucci, Ajrouch, and Manalel, 2017).

Data has become so complex and vast that technology is required to provide insights (Hariri, Fredericks, and Bowers, 2019). This is necessitated by the sheer volume of data and its variety in that it is structured, unstructured, and semi-structured, requiring tools to deal with diverse data types (Seyedan and Fereshteh, 2020). Technology has provided the computational power, algorithms, and visualization tools to arrive at actionable insights (Maddigan and Susnjak, 2023).

Low-code (LC) refers to a software development approach that minimizes hand-coding by using visual interfaces and pre-built templates, facilitating and automating the creation of applications (Sanchis et al., 2019). Low-code platforms (LCPs) are the tools and environments that enable LC development. A low-code system (LCS) promotes rapid application development, deployment, execution, and

management of systems through programming abstractions, breaking code into more manageable parts, and focusing on high-level functionality, making code reusable and modular (Vincent, Natis, Iijima, Wong, Ray, Jain, and Leow, 2021). An LCS uses programming abstractions such as model-driven and metadata-based programming languages and manageable implementations, supporting user interfaces (UIs) such as dashboards, business processes, and data services (Vincent et al., 2021).

No-code (NC) application platforms require text entry for formulae or simple expressions and, therefore, can be implemented by citizen developers. While no development skills are needed for those configuring, associated skills could still be required for configuration tasks. The advantages of implementing Low-code, No-code (LCNC) systems are privacy, rapidity, cost and complexity reduction, easy maintenance, business profile involvement, and minimization of unstable or inconsistent requirements (Sanchis et al., 2019; OutSystems, 2019). The developments in LCNC systems were driven by obtaining research data from multiple sources in automation and generating intelligence-driven insights without coding them (Sufi, 2023).

The increasing demand for LC systems is fuelled by the demand for scarce specialized expertise (Shen, Shen, Luo, Yang, Hu, Zhang, Tai, and Wang, 2023). LC tools facilitate iterative development, offering debugging and code improvement capabilities (Rokis and Kirikova, 2023).

The availability of LCS has accelerated digital transformation through citizen developers who are often business users familiar with their firm's needs and workflows but without coding experience and who can improve internal processes and the responsiveness of the business. They use visual development environments, pre-built

components, and workflow templates to develop applications to meet specific business needs (Sahay, Indamutsa, Ruscio, and Pierantonio, 2020).

Visualization presents information or concepts as a mental image designed to communicate a message ((Padilla Creem-Regehr, Hegarty, and Stefanucci, 2018), aiding clarity (Bresciani and Eppler, 2009) and comprehension time. Visual analytical representation acknowledges boundaries evolving through emergent stages, progressively helping to integrate diverse disciplinary knowledge (Bhavnani, Visweswaran, Divekar, and Brasier, 2019). This enables team members from multiple disciplines to play primary and supportive roles in transforming the visual representation of the data, enabling the team to arrive at novel translational insights that can then be shared (Akpan and Akpan, 2021). Visualization can also enhance the performance of people and systems (Bresciani and Eppler, 2009).

Increasing development capability and decreasing developer skill-set requirements enable enterprises to address business capability dynamically (Ferraris et al., 2019; Ji-fan et al., 2017; Mikalef, 2021). Management, technology, and talent capability are crucial to improving firm performance (Teece, 2016). A Subject Matter Expert (SME) is the more common term for citizen developers and will be used henceforth.

Big Data Analysis (BDA) can be defined as examining and interpreting big data sets to uncover patterns, trends, and insights (Chen, Mao, and Liu (2014). The main reason for the growing use of BDA is that it is increasingly recognized as a potential source of competitive advantage through offering insights into strategic innovation (Zhang, Shang, Cheng, and Hu, 2022). Research on 814 BDA implementations found a 3% to 7% improvement in revenue after BDA implementation (Müller et al., 2018). Ji-fan, Samuel,

Wamba, Akter, Dubey, and Childe (2017) also linked the application of BDA to increased performance, as did Ferraris et al. (2019). Müller et al. (2018) found that firms in highly competitive industries gained increased value from BDA assets relative to other sectors. Shabbir and Gardezi (2020) found that applying BDA accounted for 55.3% of the improved firm performance after mediating KM practices.

1.2 Research Problem

The Professional Service Firm (PSF) sector is one of the most rapidly expanding, profitable, and significant sectors of the global economy (Hinings, 2015). This includes the accounting, management, legal, and architectural sectors. Broadly, service work refers to harnessing knowledge to benefit others (University of Cambridge et al., 2015).

This research is based in the legal industry within the service sector and relates to decision-making with large, complex, dynamic data. The industry's main challenges in budgeting and forecasting are revenue uncertainty, seasonality, shifts in sector demand, competition, an innovative environment requiring investment, regulation, and compliance, and economic fluctuations (Felin and Powell, 2016).

Data analytics seeks to gain insight into strategic and operational management decisions by creating heuristic algorithms and models. In an era of the growing availability of big data, data analytics is increasingly viewed as an essential competitive capability of firms, including those in the service industry. The rate at which this data accumulates also demands real-time or near-real-time insights.

It has been established that big data analytics (BDA) relating to the pricing and quality of legal services (i.e., pricing analytics) reduces uncertainty (Agrawal, Gans, and Goldfarb, 2018; Susskind and Susskind, 2017). Experts wielding BDA tools can also enhance revenue and profits (Akter, Wamba, Gunasekaran, Dubey, and Childe, 2016). This is achieved by identifying and analyzing patterns, leading to strategic action (Neirotti and Paolucci, 2007; Rivard, Raymond, and Verreault, 2006; Shabbir and Gardezi, 2020).

Vast datasets introduce complexity and hinder efficient management decision-making. However, data pattern visualization mitigates this (Alhadad, 2018; Chiang, Grover, TingPeng, and Dongsong, 2018). Data scientist describes a professional using scientific methods to extract insights and create meaning from raw data (Provost and Fawcett, 2014). By transforming statistical patterns into visual representations, interdisciplinary communication between data scientists and managers is facilitated, enabling actionable decisions (Alhadad, 2018; Agrawal, Gans, and Goldfarb, 2018; Chiang et al., 2018; Susskind and Susskind, 2017). When data scientists visualize data patterns for managers, uncertainty is converted into reliable conclusions, promoting effective management decision-making and action (Shabbir and Gardezi, 2020).

While all disciplines require data-driven decision-making, visuals may drive different disciplines to a greater or lesser extent. Data visualization is a form of interdisciplinary communication between stakeholders that enables strategic management decisions.

This study studies visualization communication between teams responsible for Information Systems, Knowledge Management (KM), Communications Technology, Financial Management, and Strategy in their budgeting and

forecasting planning activities. These planning activities require an alignment of data, technology, and people. The various SMEs and SEs need to make financial planning decisions based on their shared understanding of complex data using technology.

The service industry is considered an early adopter of technology, with a more significant budget percentage than other industries (Alarie Niblett and Yoon, 2017). The emergence of LC and NC systems empowered SMEs to play a significant role in configuring budgeting and forecasting systems with little coding experience. Moreover, the LCP is a workflow system as the flow of tasks is controlled and the interactions are limited, enabling the control of process flow, users, and timings of the steps involved to optimize and make the processes more efficient. LCSs often include pre-built templates for workflows that are customizable for business needs. OutSystems, Mendix, and Tagetik are examples of these. In previous studies, LCS and, more specifically, workflow improved profitability (Cuthbert and Pearse, 2021).

LCS availability and functionality of LCSs, along with access to statistical packages such as R or Statistica, have enabled data scientists to identify patterns in the data. These patterns are then presented in reporting packages such as Tableau and Power Business Intelligence (BI). Some legal firms have proprietary systems already configured in cubed data formats and dashboards, such as Qlikview and Tagetik.

Legal technology can be defined as technologies and IT solutions supporting those providing legal services (Kerikmäe Hoffmann and Chochia, 2018). This research relates specifically to those tools that support budgeting and planning. Given that Artificial Intelligence (AI)

and Large Language Models (LLMs) were not as widely accessible and prevalent 5 years ago when this study was started, they are not included as tools for visualization or automation for decision-making but are included in the recommendations.

Within the legal setting, interdisciplinary SMEs who are functional knowledge experts in their area of expertise and SEs responsible for the system configuration and customization of the applications within their specialist area, are responsible for budgeting and forecasting. Despite the extensive use of technology, this process is still heavily reliant on expert knowledge and tacit “gut-feel” information.

As this process is critical to maintaining a firm’s competitive advantage, removing the reliance on experts would go a long way in ensuring sustainability and longevity of the firm. To accomplish this, it is necessary to understand the current use of technology within this process, as well as to formalize the human process in preparation for some form of automation in the future.

1.3 Underpinning Theory

Several existing theoretical models and frameworks can assist in the formalization process, including resource-based theory (RBT), Contingent Resource-Based Theory (CRBT), and the SECI model.

RBT arose because a framework was required to explain and predict a company’s performance and competitive advantage (Barney, Ketchen, and Wright, 2021). Porter (1989) felt that a firm’s internal factors, such as resources and capabilities, determine its profit. Penrose (1995) developed the Theory of Growth of the Firm (TGF), first

published in 1959, stating that the resources a firm is accustomed to working with and management experience shape the services its management renders. Barney (1991) then developed an approach to strategic management focused on competitive advantage, becoming the dominant strategic management paradigm of the time.

By highlighting capabilities (Brandon-Jones, Squire, Autry, and Petersen, 2014), CRBT addresses the contextual insensitivity of RBT's managerial framework (Chae, Yang, Olson, and Sheu, 2014; Ferraris et al., 2019). Context factors such as policies, culture, and social influences should be addressed. CRBT has been applied to analyzing big data, treating its visualization as interdisciplinary communication (Ferraris et al., 2019). Within the context-specific contingency resource-based theory, technology is seen as a dynamic capability that can be leveraged to achieve strategic advantage through knowledge-based management decisions (Chae et al., 2014). CRBT, can thus provide a conceptual framework for discussing the harnessing of value from data analytics visualizations in legal technology.

The SECI model was developed by Ikujiro Nonaka and Hirotaka Takeuchi (Nonaka, 1994). The letters in the acronym denote Socialization, Externalization, Combination, and Internalization. It is a framework for understanding the creation and management of knowledge within firms. The first phase refers to socialization and sharing and typically refers to knowledge being transferred through observation, imitation, and practice. The second phase, externalization, refers to tacit-to-explicit sharing through dialogue and reflection. This phase involved documents, manuals, models, rules, and configuration. The third phase, combination, integrates information, often through databases, documents, and other media. Finally, internalization refers to explicit-to-tacit knowledge processing and involves learning by doing, where individuals apply explicit knowledge in practical situations and internalize it through experience (Nonaka, 1994).

1.4 Research Statement and Objectives

Law firms employ budgeting and forecasting systems, but these systems rely heavily on human intervention to configure their budgeting and planning cycles and scenario analysis. Management needs to harness dynamic technical capability to leverage legal competitive advantage, and strategic decision-making is vital for law firms that wish to extend their competitive advantage (Ajgaonkar, Neelam, and Wiemann, 2022). The research seeks to understand the Knowledge-Sharing (KS) process by investigating a planning tool's legal and financial system implementation as part of a more comprehensive financial transformation project.

Establishing how technology, planning and forecasting SMEs and SEs, and data contribute to knowledge-based management decisions in interdisciplinary teams, thereby expanding the bundle of resources that increases a firm's competitive advantage, is critical.

The research requires an understanding of how an interdisciplinary team operating in uncertain conditions uses big data in complex tasks to make timely, efficient strategic and operational decisions arriving at global insights. The research problem investigated in this research is of an applied nature. Big data and complex task attributes require sensemaking (Bresciani and Eppler, 2009; Shabbir and Gardezi, 2020). Vast amounts of complex data often complicate management's strategic and operational decisions (Ferraris et al., 2019; Ji-fan et al., 2017). Interdisciplinary groups require an analysis tool to make sense of the assumptions and structure the process.

This research aims to establish and formalize how law firms make decisions by combining data, technology, and people as a bundle of resources and capabilities to enable decision-making.

The associated research objectives are given as follows:

1. Determine which types of information technology (specifically information systems supporting decision-making) contribute to the competitiveness of a firm.
2. Develop a process model of how visualization and information systems facilitate human decision-making.
3. Verify how the proposed model replicates strategic and operational decision-making in practice.

1.5 Research Scope

This research focuses on the relationship between data, technology, and people enhanced by visualization. In the process studied, SMEs and SEs configure assumptions with visualizations within interdisciplinary teams to enable budgeting and planning within legal practice management systems. The role of visualizations as a communication, sensemaking, and feedback mechanism in interdisciplinary teams within a legal environment is investigated. Management must explore reducing complexity by using visualization for interdisciplinary communication and sense-making (Bresciani and Eppler, 2009; Shabbir and Gardezi, 2020). This is done to enhance value and profit (Müller, Fay, and Vom Brocke, 2018) and to accumulate core competence (Shabbir and Gardezi, 2020). The research looks to extend CRBT, focusing on People, Technology, and Data, and investigates how industry experts develop holistic solutions to complex, real-world challenges.

1.6 Research Approach

A pragmatic research approach is suitable for addressing the multi-faceted challenges experienced in the budgeting and forecasting planning process. Pragmatism is more inclusive, adaptive, and practically relevant for solving real-world problems and was adopted as the most suitable approach in this research (Morgan, 2007).

This research employs a mixed-method approach due to the complexity of the problem. The first phase relies on quantitative research through an exploratory study that establishes which LC systems improve competitive edge. Quantitative research is characterized by traditional, disciplinary-based academic research and is conducted within the boundaries of a specific academic discipline (Gibbons, 1994). It is educational and driven by the quest for knowledge and understanding with well-established norms and practices within scholarly communities.

The second phase of this research involves a more prominent qualitative component in the form of an explanatory study focusing on the relationship between data, technology, people, and visualization's role. Qualitative research shifts toward more application-oriented and context-driven research (Waghid et al.,2020). Driven by practical problems and real-world applications, it involves diverse stakeholders, including industry, government, and communities. Flexibility and adaptability are required to meet changing societal needs and technological advancements. This research employs qualitative deductive thematic analysis based on qualitative interviews to determine the role of visualization at the various stages of the knowledge process. A qualitative approach focusing on interdisciplinary communication is adopted in this real-world research between multiple departments.

Modern challenges often transcend disciplinary boundaries, requiring integrated approaches. There is an increased demand for research to

provide practical solutions to societal issues. New technologies facilitate collaborative and interdisciplinary research.

Interdisciplinary research combines diverse fields to generate innovative concepts (Coombs, Hislop, Taneva, and Barnard, 2020). Primary transcendent theoretical approaches can be produced by mixing and fusing the results of different fields into a new conceptual and methodological framework. Interdisciplinary communication involves integrating methods, insights, and communication across two or more disciplines to address a topic or problem. This research approach is interdisciplinary as it combines disciplines to create a holistic approach that transcends traditional disciplinary boundaries.

Jantsch (1972) distinguishes five types of collaboration in knowledge production, which differ in their structures and degrees (Huutoniemi, Klein, Bruun, and Hukkinen, 2009). Multi refers to multiple disciplines working together, providing insights from their fields without integrating their methodologies and theories. Pluri refers to various disciplines working together, but exchange and collaboration are minimal. Cross implies exchanging and integrating knowledge between different disciplines to address a specific problem. Inter refers to researchers from various disciplines collaborating and merging distinct methodologies and theories to create a unified framework and interdisciplinary collaboration.

1.7 Thesis Structure

The first chapter discussed the research area and setting and introduced the key terms and concepts. Technology and task complexity were introduced, as was data analytics and its role in decision-making. Accessible technology such as LCS is introduced,

along with the citizen developers that enable them. The role of data visualization is discussed. The underpinning theories are introduced: RBT, CRBT, and the SECI process. The research scope, problem, aim, and approach are defined. The mixed-methods pragmatic approach is discussed along with the components of this research, namely a more minor LC quantitative study, and a qualitative explanatory study.

The second chapter outlines the research methodology, including the mixed-methods and post-positivism approach. Pragmatism and an interdisciplinary approach are also highlighted. The research methods, data collection techniques, data analysis methods, quality standards, and research ethics are all discussed.

The quantitative study is expanded in the third chapter with its CRBT underpinnings and data as a resource and a technological capability. The findings are outlined and discussed.

The fourth chapter discusses the process of leveraging LC systems with visualization. This chapter explores people as a resource, KS, and conversion, as well as the role of visualization in CRBT and interdisciplinary communication. A process model for leveraging LCS with visualization to facilitate human decision-making has been developed.

Qualitative findings supporting the process model developed are the focus of the fifth chapter. The findings are discussed in terms of socialization, externalization, combination, and internalization, and the main findings are summarised.

The sixth chapter interprets the findings regarding the overall visualization themes, the future of visualizations, and the implications for the study. The limitations of the study are included.

Finally, Chapter 7 reintroduces the research and summarises the findings—the study's contributions. The objectives are revisited, and recommendations for future research are made. The chapter is summarized, and concluding remarks follow.

CHAPTER 2 RESEARCH METHODOLOGY

2.1 Introduction

This research aims to establish how law firms make decisions by combining data, technology, and people as a bundle of resources and capabilities to enable decision-making. Initially, a quantitative phase was used to determine which types of technology contribute to a firm's competitiveness. The literature was then reviewed in the second phase, and a process was developed to understand how knowledge is shared and visualization, together with systems, facilitates decision-making. The process was then studied in practice with a qualitative component, interviewing SEs and SMEs and analyzing the emerging themes.

This research design is sequential (Notation: quan →QUAL). In an explanatory sequential design, quantitative data is collected first, followed by qualitative data (Greene, Caracelli, and Graham, 1989), and the quantitative data is elaborated with additional qualitative information (Kramer, Laher, Fynn, and Janse van Vuuren, 2022). The findings of the first quantitative research inform the second qualitative research. The study identified a direction during the first phase, then investigated with literature and thematically analyzed in the qualitative component.

Other studies also used an initially more minor component to expand on the larger area to gain a more in-depth understanding in a second phase. For example, quantitative data was collected and analyzed in a different study to identify risk factors associated with safe sex practices among adolescent females (Creswell, Plano Clark, 2011). Researchers conducted interviews with adolescent females to gain a

more in-depth understanding of these risk factors in the context within which they occurred (Creswell, Plano Clark, 2011). This design was also employed in a middle school jazz education study with a qualitative exploration of middle school jazz education for which observation, field notes, interviews, and artifact data were collected (West, 2011). Findings generated from the qualitative study informed the development of a survey instrument used to collect data from a larger population of middle school music teachers (West, 2011). Another example of this approach was in a study relating to the impact of Airbnb on the traditional hospitality industry (Yoon, 2011). A Phase 1 study investigated individuals' trust in hospitality choices. After gaining greater insight from the interviews, a research framework was developed for the quantitative Phase 2 study. In the second phase, generalizations were developed about the precision of the relationship among the constructs obtained from Study Phase 1 (Yoon, 2011).

Excellent quantitative and qualitative research skills are required in this approach, and any contradictions arising from the different approaches between the two distinct phases should be considered insights (Kramer, Laher, Fynn, and Janse van Vuuren, 2022).

2.2 Mixed Methods Research Approach

The research approach typically refers to the procedure you have selected to collect, analyze, and interpret (Hesse-Biber, 2015). This research had a quantitative and qualitative phase and was a mixed-methods approach. Employing a mixed-methods pragmatic paradigm with a small quantitative component, followed sequentially by a more extensive qualitative study, this research seeks to understand visualization's nuanced role in decision-making processes.

2.2.1 Quantitative research

This research studied the impact of different decision-making software systems.

The first research objective was to determine which types of information technology (specifically information systems supporting decision-making) contribute to a firm's competitiveness (Cuthbert and Pearse, 2021).

A quantitative approach was used to assess this.

The hypothesis for the research is as follows:

H₀: There is no significant difference in a firm's average revenue based on their strategic use of an LCP.

H₁: There is a significant difference in a firm's average revenue based on their strategic use of an LCP.

2.2.2 Qualitative research

The second research objective was to develop a process model of how visualization and information systems facilitate human decision-making. The research then tried to understand how the proposed strategic and operational decision-making model occurs in practice.

Phase 2 consisted of a literature review of the KS process, resulting in the development of a conceptual KS model. A thematic qualitative study of interviews focusing on SMEs' and SEs' use of visualization in legal and financial system implementation was employed as Phase 3. The thematic analysis explores patterns, trends, and relationships (Braun and Clarke, 2006), including gathering relevant documents and conducting qualitative

interviews using a guided questionnaire. Razmdoost, Alinaghian, and Linder (2020) felt that methodological diversity provides richer insights for triangulating data, increasing the validity and reliability of the findings and driving research.

A qualitative study is a suitable method of exploring and providing new knowledge for a complex area and an exemplary method for in-depth analysis to offer contextual real-life information on relationships (Piekkari, Welch, and Paavilainen, 2009), in this case, the relationship between people, technology, and data.

Utilizing online interviews with SMEs in legal system implementation, experts were asked questions about communication, system configuration, and the role of visualization. The themes extracted from these interviews are compared to those in the KS model developed in phase 2, highlighting visualization's role in the KS process.

The qualitative primary research design includes thematic research of qualitative interviews. The thematic analysis explores patterns, trends, and relationships (Braun and Clarke, 2006). Themes relating to visualization, enhancing budget accuracy, and generating a better understanding based on empirical data are analyzed. The refinement of assumptions by SEs and SMEs from various geographical regions is explored using an online interview guided by a set of questions. Core competencies, capabilities, and competitive advantage are investigated through the framework of CRBT, focusing on how they are enabled through visualization. The objective is an in-depth understanding and insight into competitive advantage with specific reference to visualization.

2.2.3 Pragmatism

Pragmatism is a philosophical approach that prioritizes real-world applications over theories and ideas and is often associated with mixed-methods research (Morgan, 2014). This paradigm bridges the gap between the scientific method and naturalistic new methods (Kaushik and Walsh, 2019). It is often a relevant and valuable paradigm for qualitative research on organizational processes (Kelly and Cordeiro, 2020). Actionable knowledge and a focus on interrogating the value and meaning of the research data by examining its practical consequences underlie this approach (Morgan, 2014). Pragmatism accepts that single or multiple realities are open to empirical inquiry (Kaushik and Walsh, 2019) and is seen to be in the middle of objectivity and subjectivity, offering a more reflexive approach (Morgan, 2007; Olaghere, 2022).

In the 1950s and 1960s, post-positivist researchers conceded that multiple realities exist in the social sciences. Pragmatists felt that the investigators' values influenced research and began advocating mixing the methodologies and argued that researchers should utilize the strengths of both paradigms to provide a more complete understanding of educational and social phenomena (Creswell & Plano Clark, 2007).

Utilizing inductive and deductive logic, pragmatists value objective and subjective points of view, the generative nature of qualitative research, and the reductive nature of quantitative research. By the late 1950s, the social sciences community was receptive to mixing methods to triangulate data valuing using multiple (quantitative) methods with offsetting strengths and weaknesses to examine the same phenomenon (Creswell & Plano Clark, 2007).

Later in the formative period (1960s and 1970s), researchers began combining surveys and interviews and, finally, qualitative and quantitative techniques. During the mid-1980s to the mid-1990s, researchers continued discussing whether qualitative and quantitative data could be combined (Creswell & Plano Clark, 2007). In the 1980s and 1990s, researchers began to define types of mixed methods systems and describe procedures for conducting mixed methods research (Creswell & Plano Clark, 2007). With sequential triangulation, the results of one method inform the planning of the next method. Later researchers such as Creswell (1994) elaborated on this classification system.

In social research, the term paradigm refers to the philosophical assumptions or beliefs that guide the researcher's worldview (Slevitch, 2011). All paradigms encompass axiology – ideas about the role of values and morals in research; ontology – assumptions about the nature of reality; epistemology – assumptions about how the world gains knowledge and shared understanding; and rhetoric, which is a shared understanding of the language of research (Kaushik and Walsh, 2019).

Morgan argues that a pragmatic approach is less concerned with ontological debates over the nature of reality and more focused on the outcomes and effectiveness of research practices in addressing specific problems (Morgan, 2007). Accepting that reality is constructed through human interactions and is subject to change; the research focuses on the practical aspects of real-world application.

Axiology refers to the researcher's understanding of values and their role in research. The axiology of pragmatism is that values are relative and situational. Goldkuhl (2012) explores how pragmatism views

values as relative and context-dependent, emphasizing research's practical application and outcomes. The practical application of knowledge in specific contexts is acknowledged by integrating subjective and objective viewpoints (Phillippi and Lauderdale, 2018). Regarding axiology, pragmatists recognize that research is value-laden, and values play a critical role in the research process and in solving problems. Focussing on the practical consequences of research, they attempt to solve problems and bring about change (Elo, Kääriäinen, Kanste, Pölkki, Utriainen, and Kyngäs, 2014).

The researcher intended to discover if visualization enabled interdisciplinary communication in an interdisciplinary team. The value and meaning of the research data were evidenced by examining its practical consequences, as also supported by Morgan (2014). In this research, the methodology included a pragmatic inquiry, as individuals can experience change differently, and flexibility (Morgan, 2014) in the research technique is thus critical.

Post-positivism emphasizes empirical rigor, and pragmatism focuses on practical application, and many researchers believe the two can be successfully combined (Creswell, Plano Clark, 2011; Kramer, Laher, Fynn, and Janse van Vuuren, 2022; West, 2011). For example, in this research, the quantitative component can point out an area to explore, while the qualitative component can offer deeper, context-specific understanding. Regarding methodological flexibility, pragmatism supports methodological pluralism, allowing researchers to use various methods to investigate complex phenomena, aligning with post-positivism's acceptance of quantitative and qualitative methods to capture different aspects of reality. Regarding practical relevance, pragmatism ensures that the research remains relevant and practically applicable. Finally, in terms of critical reflexivity, pragmatism encourages researchers to be critically reflective about their biases and

the limitations of their methods and findings, enhancing the robustness and credibility of the research (Finlay, 2002).

2.3.1 Phase 1 Quantitative Research

2.3.1.1 Data Collection for the Low Code System Exploration

The top 50 firms from the [Legal Insider Top 200 list](#) for 2020 (Top 200, 2021) were selected for categorization based on their LCP systems. The top 50 firms were chosen as they tend to be leaders in system implementations and drive the adoption of innovative LC and Business Intelligence (BI) systems. The ability to execute and completeness of vision moderators, measured through capabilities and strategy and innovation, respectively, were derived from a Gartner Report focusing on the implementation of enterprise LCSs delivering high-productivity and multi-function capabilities across central, departmental, and citizen development functions (Vincent et al., 2021).

Vincent et al. (2021) used evidence collected through vendor surveys, questionnaires, interviews, demonstrations, and sentiment analysis undertaken by the Gartner Secondary Research team. Execution relates to product capabilities and implementation and sales execution and pricing, while vision relates to product strategy, innovation, and marketing strategy (Vincent et al., 2021). LCSs were required to demonstrate a 'go-to-market' strategy for cross-industry application development. To be included in the Gartner Report, the LCSs needed to have demonstrated LCS capabilities, 20% year-on-year growth in revenue for LCS licenses, and at least \$12 million for LCS licenses for the year ending March 2020. As per the classification of Vincent et al. (2021), LCPs are categorized as Leaders, Challengers, Visionaries, or Niche Players. Leaders have a strong market presence and extensive functionality. Challengers have a solid market presence but often have less breadth of functionality than the leaders have. Visionaries have a forward-thinking market approach and focus on

innovation but don't often have an established market presence. Niche Players offer deep expertise and highly tailored offerings.

2.3.1.2 Data Analysis for the Low Code System Exploration

The Gartner categorization is used as a strategic LCS classification measure to ascertain whether strategic implementation of LCSs leads to increased revenue. Law Firms were divided into categories. Data from the Legal Insider Top 200 was used. It was conducted by categorizing the firms according to their LCS use using an Analysis of Variance (ANOVA) and testing the hypothesis to establish if there were significant differences in average revenue for 2015 – 2018 based on their strategic use of an LCS. Firms featured as Leaders and Niche Players with most classified as Unknowns (i.e., the legal firms that appeared to have yet to implement LCSs).

2.3.2 Phase 2 Qualitative Research

2.3.2.1 Data Collection for the Qualitative Study

Eight SME interviews were held with seven participants, with one participant being interviewed twice due to follow-up observations being contributed. Table 1 reflects the years of system implementation experience.

Table 1. Years of Experience for SMEs and SEs.

Respondent Number	Type	4-14 yrs	15-24 yrs	25-34 yrs
1	SME			✓
2	SME	✓		
3	SME			✓
4	SME	✓		

5	SME		✓	
6	SME			✓
7	SME	✓		
8	SE			✓
9	SE			✓
10	SE		✓	
11	SE			✓

The four SEs are experts in configuring the application's workflow rules and other configurations once these have been set according to the SMEs' specifications. The SEs were used to validate the viability of the conceptual use case proposed by the researcher.

The researcher employed a convenience sampling technique based on previous implementation contacts, supplemented through the snowballing technique, where respondents were asked to recommend other relevant respondents. Regarding the recruitment process, an email was sent to all respondents, including a letter of invitation outlining all the details and the information requesting their permission to participate. The sessions were then scheduled. These interviews were recorded and transcribed. An interview guide guided the sessions. The sessions were approximately one hour long. The voice interviews were all stored as per the RU ethics application requirements.

Another data collection technique was asking the respondents to send through their sample visualizations. The respondents were individual contractors who specialized in financial applications and have all worked for multiple law firms. They were asked about their experience across their careers relating to various clients.

2.3.2.2 Data Analysis for the Qualitative Study

A guided questionnaire was devised, and the propositions were as follows:

1. Visualization aids the sharing of SME and SE knowledge by ascribing and conveying the importance of some underlying principles.
2. Visualization aids in explicitly making rules relating to sequence and processes. Complex data is simplified.
3. Visualization aids the facilitation of agreement between SMEs and SEs regarding best practices.
4. Visualization aids in the assimilation and adoption of new processes by SMEs and SEs.

The sessions were conducted in Zoom, and the Zoom Artificial Intelligence (AI) functionality summarised the responses. Artificial Intelligence (AI) uses Machine Learning (ML) to make predictions and reach conclusions from the data, improving results from feedback (Frey, 2021; Jha, Doshi, Patel, and Shah, 2019; Liu, Jin, Yan, Tao, and Lin, 2019) and augmenting human cognitive capabilities.

The researcher switched on the Zoom AI and the recording functionality. The questions were posed to the SMEs and SEs, and where more depth was required, the researcher asked further questions. The researcher provided this where clarification was sought. The questions are attached in Table 8 and Table 10. In addition to the questions, samples of the visualizations discussed were requested to be sent through.

Then, using the Zoom AI functionality, the responses to each question were summarised by entering the proposition in the prompt and allowing the system to provide the summary by removing all pauses and expressions such as uhm, etc. All identifying information was removed. The researcher checked these summaries for accuracy; a few were spot-checked for

completeness against the original transcript. These summaries were sent to the recipients to check that they reflected the interview and were complete. This was also to verify that all identifiable information had been removed.

The summaries were then analyzed for the themes identified, and once the main themes were evident, the data was summarised into tables for the phases, reflecting the themes. Themes were also extracted using GPT4.0 as an additional source to check that the themes identified were exhaustive. Chat GPT is a reliable tool for analyzing themes in academic research, including its use in thematic analyses (Cao, 2023; Liu, Han, Ma, Zhang, Yang, Tian, He, et al., 2023).

The following themes were extracted after summarizing the responses in ZOOM AI functionality and then using GPT4.0 to extract the themes with the researcher. Themes found in the previous version of GPT3 with four responses were compared to themes found with GPT4.0, and all themes were combined to ensure the list was conclusive, as indicated in Figure 1.

No	Question	Common Themes 1	Common Themes 2
	Summary	<p>Importance of Visualization: All participants believe visualization is crucial in understanding, communicating, and verifying data and processes.</p> <p>Communication: Visualization aids in effectively communicating complex information. It helps make abstract concepts more tangible and understandable, especially during workshops, presentations, and for subject matter experts.</p> <p>Verification and Testing: Visualization is used as a tool for validation and testing. It helps identify where data is passing or failing and highlights potential issues or areas for improvement.</p> <p>Process Explanation: Visualizations such as flow diagrams, process maps, and waterfalls are used to explain processes and results. They help distinguish between different areas and processes.</p> <p>Accessibility and Understanding: Visualization makes it easier for more people, beyond those familiar with the</p>	<p>Visualization aids in understanding workflows, particularly in data conversion and testing. Highlights areas where data passes or fails during the conversion process.</p> <p>Training and Communication: Visual aids are essential for training SMEs to understand new processes and data. Provides system experts with detailed information about the data conversion process, necessary reports, and critical areas for checking.</p> <p>Implementation and Testing: Visualization tools like data mapping and logging are vital for identifying issues and areas for refinement. Visual cues, such as maps of data conversion, aid in process verification and communication.</p> <p>Use of Visual Aids: Various visual aids such as Microsoft Visio, flowcharts, diagrams, and PowerPoint presentations are used. Visual tools explain complex processes like billing workflows and ensure consistent understanding among regional SMEs.</p> <p>Consistency and Standardization: Visual tools are used consistently across projects for clarity. Lack of</p>

Figure 1: Example of matching exercise between versions.

This was done by combining all respondent answers for a specific proposition and removing anything irrelevant. No relevant responses were deleted. Samples of the visualizations employed were requested from the respondents. Some respondents declined due to confidentiality, but others supplied these, and any identifying information was removed. All recorded sessions have been stored on a shared drive.

2.4 Quality Standards

As mixed methods studies contain qualitative and quantitative strands, researchers should be cognizant of the quality considerations central to qualitative and quantitative research. Quality issues apply at paradigm, research method, and data collection technique levels.

2.4.1 Paradigm Quality Standards

At a paradigm level, the assumptions inherent in the different paradigms must be reconciled (Cresswell and Clark, 2011). Objective measures must be reconciled with subjective experiences. No assumption issues arose from this research's quantitative versus qualitative paradigms.

2.4.1 Research Method Quality Standards

At a research method level, the methodological rigor must be maintained in both paradigms.

2.4.1 Quantitative Research Method Quality Standards

In the quantitative phase, statistical validity was maintained. Limited findings due to limited representation were highlighted at the outset.

2.4.2 Qualitative Research Method Quality Standards

In the qualitative phase, data saturation and credibility were important. To elicit rich data from participants, the researcher needs to maintain the highest level of respect for their participants to establish and maintain rapport. Rapport building was significant, and the researcher did have a follow-up interview in one instance. Lastly, in reporting qualitative data, researchers need to be aware of their subjective interpretations of the data and follow procedures for maintaining rigor in qualitative research (Kramer, Laher, Fynn, and Janse van Vuuren, 2022). Consistency can be improved by checking with the SMEs during and after the qualitative interviews to ensure their summaries were representative (Piekkari et al., 2009). The researcher kept an audit trail of all research decisions, such as when data

was deleted as irrelevant, storing all the voice recordings, and noting the activities documented in the implementation study, allowing others to follow the same process.

Qualitative data presents challenges regarding interviewer bias and respondents' authenticity (O'Cathain, and Nicholl. 2010). Triangulation can be ensured by using different sources of evidence, such as online project documents, visualizations provided by respondents, and methods, including qualitative reviews, to cross-check the data and interpretations (Johnson, O'Hara, Hirst, Weyman, Turner, Mason, Quinn, Shewan, and Siriwardena, 2017). In this study, the respondents supplied visualizations from financial transformation projects.

2.4.3 Data Collection Quality Standards

The data collection technique level in the quantitative component reliability and validity are concerns. In Phase 1, the sample size is mentioned as a constraint at the outset. However, the purpose of this phase was to surface the area of exploration in the second phase of the research. In Phase 2, contractors from law firms were included in the sampling, and snowball sampling was employed during the qualitative interviews (Braun and Clarke, 2023) to expand the number of respondents interviewed.

2.5 Research Ethics

The Rhodes University Human Research Ethics Committee (RU-HREC) reviewed and approved the research proposal. The approval number was 2024-7860-8712. All standards as defined by the RU-HREC were adhered to and helped ensure the research was conducted rigorously and ethically, leading to credible and meaningful findings.

Within quantitative research, the emphasis is on anonymity protection and ethical management of collected data. In these studies, researchers may not need to know the names of participants, as they are one of many, and the aim would be to generalize findings. The emphasis would be on maintaining the anonymity of the data, ensuring that only researchers with permission are granted access to the data and that the original, captured data is safely stored.

Qualitative research shares similar ethical considerations. However, given the more complex interaction between the participant and researcher, several more ethical considerations must be considered. Firstly, in qualitative research, it is crucial that researchers properly negotiate access to participants and that every effort is made to respect the participant and their environment and to disclose the purposes of the research. Deception in research is an ethical transgression, and ethics committees seldom allow covert observation. Secondly, researchers need to be cognizant of the effects they may have on participants during their interactions. Thirdly, principles of autonomy, beneficence, and justice are strictly followed. As such, participants must make informed decisions about their participation and should not be harmed or exploited during the research. In qualitative research, every effort must be made to conceal the identifying characteristics of the person from whom data was collected. (Kramer, Laher, Fynn, and Janse van Vuuren, 2022).

The researcher provided the informed consent information to the respondents. The letter sent to obtain consent is attached in Table 19. Qualitative interview responses were recorded to ensure other researchers could evaluate the applicability of these findings to their research.

In this research, the transcripts were initially referred to with initials only, and after that, they were referred to as 'the respondent' to protect participants' identities.

For the qualitative interviews, respondents were advised that their consent to participate would be obtained verbally during the interview. Once the online session commenced, the researcher asked permission to record the session and checked that the participant was familiar with the clauses outlined in the letter requesting permission to conduct the interview and was willing to proceed. This was then recorded as part of the online session, and the information was stored.

Regarding confidentiality and data protection, the respondents were not asked to reveal the names of their clients. The experts were interviewed in their capacity about their experience working for law firms, and no data that is subject to a non-disclosure agreement was collected. Any names were removed from the summaries.

Standards relating to informing participants were adhered to, and the researcher ensured that participants were fully aware of the research purpose, methods, and potential impacts and had freely agreed to participate. Care was taken to protect the identity and personal information of participants.

2.6 Summary

This chapter outlined the research approach: the mixed methods approach combined a small quantitative component and a larger qualitative component to identify themes to investigate whether the process emerging

from the literature was replicated in decision-making in firms. Research methods were explained, including the data collection and analysis for the quantitative and qualitative components. Quality standards and research ethics were discussed.

CHAPTER 3 QUANTITATIVE STUDY – FIRST PHASE

3.1 Introduction

Firms compete and gain a competitive advantage through decision-making (Barney, 1991). People, technology, and data provide tools to leverage and unlock this value (Marler and Boudreau, 2017). Firms should leverage resources and capabilities for decision-making (Ferraris et al., 2019; Ji-fan et al., 2017; Mikalef, 2021). Actionable insights from big data analysis are a resource that has enabled decision-making (Akter et al., 2016). RBT underpins this research (Barney, 1991) and, more specifically, CRBT (Brandon-Jones et al., 2014; Chae et al., 2014).

The objective of the quantitative study related to which types of information technology (specifically information systems supporting decision-making) contribute to a firm's competitiveness. This provided an area of technology, i.e., LCS, to focus on. The research is limited in that not all increases in profit can be attributed to introducing an LCS system. The small quantitative exercise aims to provide indications of areas for further explanation.

The research sought to establish whether LCPs were associated with increased revenue. An LCS is a software development approach that minimizes hand-coding by using visual interfaces and pre-built templates to facilitate and automate the creation of applications (Sanchis et al., 2019). Low-code platforms (LCPs) are tools and environments that enable LC development. These platforms allow users with limited programming experience to develop software through graphical user interfaces and high-level abstractions rather than traditional programming. LCPs aim to enhance productivity, limit development time, and support rapid adaptation to changing market requirements. An LCS promotes rapid application

development, deployment, execution, and management of systems through programming abstractions such as model-driven and metadata-based programming languages and manageable implementations (Sahay et al., 2020). It supports user interfaces (USs) such as dashboards, business processes, and data services (Vincent et al., 2021). LCPs enable digital transformation through their capability to support rapid application development and enterprise resilience. Features of LCSs are graphical user interfaces, interoperability support with external services and data sources, security support, collaborative developer support, reusability support, scalability support, business logic specification mechanisms, application build tools, and deployment support (Sahay et al., 2020).

3.2 Resource-Based Theory

The study was underpinned by RB theory. Barney (1991) divided a firm's resources into physical, human, and organizational capital. Physical refers to the infrastructure, access to materials, location, and physical technology (Grant, 1991). Human resources refer to the employee's knowledge, skills, training, relationships, and insights and are highlighted by Rodriguez Perez and Ordóñez De Pablos (2003) as providing a source of sustainable competitive advantage. Finally, organizational capital resources refer to a company's formal structure comprising the planning and management systems. Organizational resources also relate to its internal culture, management systems, and external relationships within its business environment (Barney, 1991). Barney introduced four conditions denoted as VRIS, namely (1) value, (2) being rare, (3) immobile (i.e., not easily transferable), and (4) sustainability. RBT focuses on internal resources, building core competence as a basis for competing, and states that it assesses whether a resource has the potential to become and generate a sustainable competitive advantage. The S, namely sustainability, from VRIS, was later replaced by an O for the firm, for example, policies and

procedures to leverage competitive advantage, becoming VRIO (Barney and Clark, 2007). The four conditions of RBT suggest that poor organizational policies, processes, and procedures may weaken a resource's potential competitive advantage (Barney and Clark, 2007). The quest to increase competitive advantage moves to leverage the firm's resources rather than merely possess them (Kozlenkova, Samaha, and Palmatier, 2014). In leveraging these resources, one needs to focus on both resources within and outside the firm. Internal resources are, for example, research and development capabilities, logistics, brand management, and low-cost processes (Kozlenkova et al., 2014), while external resources are, for example, the role of suppliers (Lewis, Brandon-Jones, Slack, and Howard, 2010), customer demand, and technology change.

RBT explains competitive advantage through resources and capabilities that are VRIO, with strategic decision-making regarding resource allocation and deployment being seen as key, focusing on advantage through resources and capabilities (Priem and Butler, 2001; Rugman and Verbeke, 2002). RBT focuses on competitive advantage in the short to medium term. The concept of dynamic organizational capabilities to underpin managerial decisions and firm performance in the face of changing external conditions was introduced by Ron and Helfat (2003) and then expanded on by Helfat and Peteraf (2009).

Firms are thought to achieve competitive advantage by utilizing critical assets and building new capabilities via learning, skill acquisition, and accumulating tangible and intangible assets over time. Hence, firms can achieve an advantage by continually recombining or reconfiguring diverse types of resources and creating new applications while meeting market demand (Ron and Helfat, 2003). Applied RBT studies, highlighting the relationship between firm performance and BDA, firm dynamic capabilities, and strategic Information Systems (IS) have been

conducted in various contexts, such as marketing (Kozlenkova Samaha and Palmatier, 2014), operations management (Lewis et al., 2010), and economics (McWilliams and Siegel, 2011; Ahmed, Kristal, and Pagell, 2014).

This research examines leveraging competitive advantage through technology as a capability. Previous decision-making research includes studies by Seddon and Currie (2017) and Setia and Patel (2013). This is a neglected area of research. The theory has been used to study business resource and capability strategy by including technology and innovation. Akter (2016) used BDA to leverage firm performance based on socio-culturalism, including diversity and inclusivity, ethical considerations, contextual understanding, stakeholder engagement, a human-centered approach, and dynamism.

This research investigated the research methods of the recent RBT papers. RBT has been used to explore and validate research in various contexts through qualitative, quantitative and mixed-method methodologies. Kamasak and Purpose (2015) undertook qualitative research using an inductive case study approach to explore how different resources and capabilities affect firm performance. This included interviews, observations, and documentation to provide an in-depth view of RBT in practice. Kruesi and Baselmans (2023) studied the hospitality and tourism sectors and found diverse applications of RBT with both quantitative and qualitative approaches. Smith and Brown (2023) integrated quantitative surveys and qualitative interviews to examine how dynamic capabilities contributed to a competitive edge in the manufacturing industry. Molina-Azorín (2007) explored integrating qualitative and quantitative methods in RBT research. They found that combining the approaches provides richer insights; however, resource value and uniqueness were sometimes found to deliver conflicting results across the methodologies. They also

advised rigorous integration to ensure cohesiveness and found this approach research-intensive. Triangulation is often required to prevent bias or overemphasis. Although mixed methods are becoming more prevalent, most studies have been conducted using a quantitative approach due to their scalability and compatibility with the theories focused on firm performance and competitive advantage (Newbert, 2007; Ristyawan, Putro, and Siallagan, 2023).

Firms can achieve competitive advantage by building new capabilities, such as domain knowledge and skills, and accumulating tangible and intangible assets to improve efficiency (Kozlenkova et al., 2014; Makadok, 2001). Assets can also be divided into tangible and intangible assets (Barney, 1991; Molloy, Chadwick, Ployhart, and Golden, 2011). Tangible resources refer to all the assets, including economic gains and visible business contributions, such as products and commodities (Lyons and Brennan, 2019). Intangible resources comprise all a company's assets related to access to capabilities and knowledge and organizational, strategic, and social benefits (Keränen and Jalkala, 2013). Intangible resources do not deteriorate with use; they can be used simultaneously by multiple managers and are difficult to exchange, for example, business process know-how and employee skills (Molloy et al., 2011).

3.3 CRBT

The CRBT is a variation of RBT, emphasizing the contingent nature of resources and the fact that the effectiveness of resources depends on internal and external conditions. Aragón-Correa, Alberto, and Sharma (2003) conducted a study that found that environmental strategy success is contingent on specific organizational and environmental factors. The CRBT addresses the contextual insensitivity of RBT,

highlighting capabilities emerging from the interrelationship between primary and secondary resources and focusing on the synergies between these resources, as they rarely act alone (Brandon-Jones et al., 2014; Chae et al., 2014). This field developed in reaction to the one-size-fits-all approach and purports that the output depends on the internal and external situation. It took shape in the 1950s and 1960s to account for firm context variability. Burns and Stalker (1969) felt that firms with more organic structures were more effective than those with mechanistic structures required in stable environments. Lawrence and Lorsch (1967) developed the approach in recognition of different firms requiring different management approaches and structures, as well as differentiation and integration to respond to various environmental contexts. Contingencies influencing differentiation and integration were considered environmental complexity and uncertainty, task variability, task interdependence, rate of change in the environment, and technological sophistication (Lawrence and Lorsch, 1967). High task variability necessitates specialized knowledge and skills.

The CRBT highlights capabilities emerging from the interrelationship between primary and secondary resources as central to competitiveness and profitability (Coombs et al., 2020; Cuthbert and Pearse, 2021; Obitade, 2019). Primary resources refer to machinery and technology and are foundational and tangible, and secondary resources are the development of capabilities, such as KS practices (Cuthbert and Pearse, 2021). Interdependent resource networks and dynamic capacity to pivot to a volatile environment provide better outcomes.

The following studies illustrate how dynamic capabilities, and contextual factors influence competitive advantage within the framework of digital and data-driven innovations. Rugman and Verbeke (2002) applied a CRBT approach in their study examining how

enterprise systems and digital platforms drive innovation. Gupta, Kumar, and Singh (2018) examined the impact of cloud-based ERP services on firm performance using a CRBT approach. Kozlenkova et al. (2014) define capabilities as the available resources within the firm and the techniques for performing the tasks relative to environmental variables. The CRBT assumes that situational or contextual variables affect the outcome. Ji-fan et al. (2017) and Mikalef (2021) found that process-orientated dynamic capabilities and operational and dynamic capabilities facilitate competitive advantage. Quantitative metrics such as flexibility and resource allocation affected the speed at which they reacted to market changes. Dynamic capabilities are the ability to develop, integrate, and respond to their environment, and many subsequent studies have built on these measures (Teece, Pisano, and Shuen, 1997). Ferraris et al. (2019) found that BDA capabilities and firm performance are linked, and that KM enhances the relationship. These studies all employ a quantitative approach. These studies all support the core idea that context dramatically affects the value of resources.

3.4 Big Data as a Resource

Nikulina (2020) found that firms that used automated budgeting systems with assumptions had higher investment returns. However, different locations, time zones, and cultures within disciplines must be overcome (Hofstede, Hofstede, and Minkov, 2010). Akter et al. (2016) highlighted that BDA could be aligned with business strategy to enhance firm performance. Wright, Stone, and Aravopoulou (2019) found that technology, management, and talent capability enhanced by big data technology can provide an accurate evaluation of the resources required for big data applications. These IT projects should also focus on sensing changes, such as shifts in the market dynamics, customer preferences, and technological advancements in the business environment and responding to them (Kozlenkova, Samaha and

Palmatier, 2014). The process must be completed promptly, efficiently, and synchronized so the team can function seamlessly (De Haan, 1999).

BDA enables management to achieve a competitive advantage, unlocking firm value and increasing revenue (Akter et al., 2016; Müller et al., 2018). Ji-fan et al. (2017) and Ferraris et al. (2019) all found that BDA enhanced organizational performance. Müller et al. (2018) and Shabbir and Gardezi (2020) found that applying BDA accounted for 55.3% of the improved firm performance after mediating for KM practices.

Predictive analytics, leveraging large volumes of data to predict outcomes, is a subset of advanced analytics that leverages various techniques from statistics, data mining, machine learning, and artificial intelligence to analyze historical and current data to predict future events (Obitade, 2019). Predictive analytics are used for pattern recognition and trend analysis, forecasting, prescriptive insights, anomaly detection, and real-time analytics (Obitade, 2019).

Traditionally, data scientists have delved into data, armed with a preconceived hypothesis to test. Increasingly, they first explore data to discern patterns, which lead to hypotheses that are then tested. Multi-dimensional mapping of the distance between points, principal component analysis, multivariate analysis of variance, and discriminant function analysis reveals patterns previously undiscerned when investigating one variable at a time in univariate analysis (Neirotti and Paolucci, 2007; Rivard, Raymond, and Verreault, 2006). The patterns identified may also be interpreted as trends. Data is analyzed for patterns, trends, anomalies, and outliers. Firms employ BDA to predict and conclude from the data, utilizing unusual activity

detection in systematic sequences of processes to deploy and manage tasks to support their strategy (Neirotti and Paolucci, 2007; Rivard, Raymond, and Verreault, 2006).

Pricing uncertainty translates to a business problem for the legal industry, and BDA has impacted the traditional billable hour delivery model by providing transparency (Susskind and Susskind, 2017). The big data analysis relating to the pricing and quality of legal services (i.e., pricing analytics) enables management to make better decisions based on the presented data (Agrawal, Gans, and Goldfarb, 2018). Future developments include a digital market for those purchasing legal services and quantitative legal prediction (Katz, 2013), where hundreds of thousands of data points, such as cases, holdings, settlements, quality, cost, and client satisfaction, are trawled in seconds.

De Haan (1999) found that the transparency of a step-by-step approach enabled the reliability of the process to be proved and validated. Researching 814 BDA implementations, Müller et al. (2018) found a 3% to 7% improvement in revenue after BDA implementation. Nikulina (2020) found that firms that used automated budgeting systems with assumptions had higher investment returns. Ji-fan et al. (2017) and Wamba, Akter, Dubey, and Childe (2017) also linked the application of BDA to increased organizational performance, as did Ferraris et al. (2019). Shabbir and Gardezi, (2020) found that applying BDA accounted for 55.3% of the improved firm performance after mediating KM practices.

3.5 Research Procedure

The research determined whether the Top 50 firms implementing an LCS earn more revenue due to actionable decisions than firms without an LCS in the UK. As explained earlier, LCSs are categorized into four quadrants based on the two axes of execution and vision: Leaders (good execution and vision), Challengers (good execution but less vision), Visionaries (good vision but less execution), or Niche Players (neither vision nor execution but good process automation) as per the Gartner classification (Vincent et al., 2021). Figure 2 illustrates this classification.

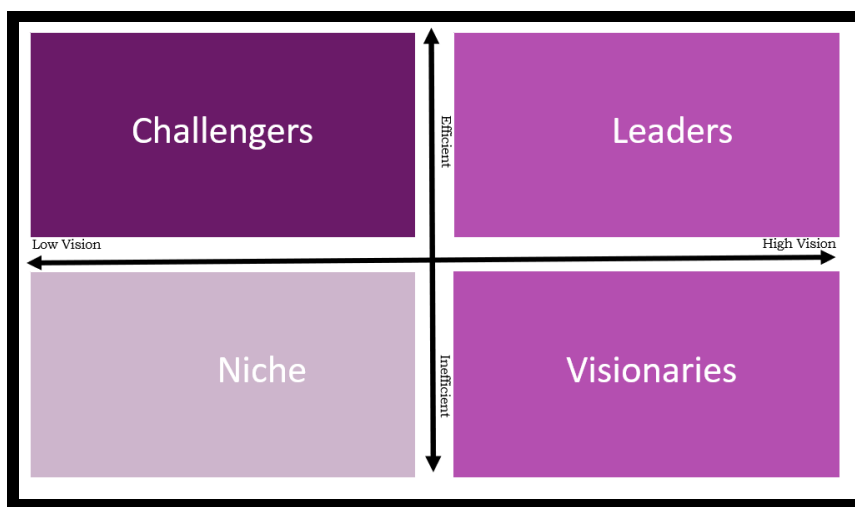


Figure 2: Classification of LCSs (Workflow) Based on Gartner Classification (Vincent et al., 2021).

In applying the classification to the Top 50 UK legal firms, LCP leaders were Microsoft, Salesforce, ServiceNow, Mendix, OutSystems Tessian, and Appian. An LCP Challenger was Oracle (APEX). Visionaries in LCPs were Oracle Visual Builder, Zoho, Betty Blocks, and Pega. LCP Niche Players were AgilePoint, AuraQuantic, Creatio, Newgen, TrackVia, Kintone, QuickBase, Intapp and ProntoForms. Intapp was also classified as a niche player as it missed the Gartner cut-off points due to supplier size, but it was a vital workflow system in the legal industry. Intapp was added to this list despite missing the cutoff due to its prominence as a workflow system in the legal technology industry. Intapp had not met the requirement for a supplier’s customer base to include at least 400 paying customer firms and

had added at least 20 new customers during the previous year as of March 2020. Ten years of experience in the following geographies was also a requirement: North America, South America, Europe, the Middle East, Africa, and Asia/Pacific. The Top 50 were selected as they tend to have bigger budgets for state-of-the-art software and can employ more resources to implement these. The Top 50 law firms were classified according to their use of LC systems according to the above Gartner classification, as illustrated in Table 2.

Table 2: Top 50 Law firms Classification according to their LC systems.

DIA Piper	1674	1566	Elite 3E + Intapp	Kira Systems	Kira Systems	Kira Systems	3,00	1674,43	Leader - 1	Niche - 2	Unknown - 3
Clifford Chance	1472	1350	Aderant Expert + Ora	Kira Systems + Neot	Kira Systems + Neot	Tessian + Kira System	2,00	1472,00	1472,00	1674,43	1378,44
Allen & Overy	1430	1280	Elite 3E	iManage Work	iManage Work	Kira Systems	3,00	1429,72	478,32	1429,72	1203,92
Linklaters	1378	1267	SAP	iManage Work	iManage Work	Kira Systems	4,00	1378,44	225,92	1373,38	461,86
Hogan Lovells	1373	1098	Elite 3E	Unknown	Unknown	Kira Systems	3,00	1373,38	152,84	1312,40	427,22
Freshfields Bruckhaus De	1312	1245	Elite 3E	Kira Systems + Neot	Neota Logic	Kira Systems	3,00	1312,40	152,80	889,30	402,68
Norton Rose Fulbright	1204	1152	SAP HANA - Fulcrum	Unknown	Neota Logic	Unknown	4,00	1203,92	138,74	840,34	304,66
Herbert Smith Freehills	889	815	Aderant Expert	Unknown	Unknown	Kira Systems	3,00	889,30	118,44	542,84	302,40
CMS McKenna Nabarro	840	753	Elite	Unknown	Brainspace	Kira Systems	3,00	840,34	103,93	193,31	288,48
Ashurst	543	586	Elite 3E	Unknown	Unknown	Kira Systems	3,00	542,84	103,36	103,02	265,80
Slaughter and May	482	417	Bespoke + Tikit Firm	Luminance	Luminance	Luminance	4,00	481,86	89,32	95,90	260,74
Clyde & Co	478	420	Elite 3E	Unknown	Unknown	Tessian	1,00	478,32			204,44
Eversheds Sutherland Intl	427	382	Elite	Unknown	Unknown	Unknown	4,00	427,22			196,88
Pinsent Masons	403	362	Aderant Expert	Unknown	Unknown	Unknown	4,00	402,68			194,18
Gowling WLG	305	172	Aderant Expert	Unknown	Unknown	Unknown	4,00	304,66			169,36
Simmons & Simmons	302	269	Avanade AX Legal (M	Unknown	Unknown	Unknown	4,00	302,40			161,64
Bird & Bird	288	259	Aderant Expert	Unknown	Unknown	Luminance AI + iMan	4,00	288,48			160,71
Bryan Cave Leighton Pais	266	259	Elite	iManage	iManage	iManage	4,00	265,80			156,80
Taylor Wessing	261	240	Aderant Expert	Unknown	Unknown	Unknown	4,00	260,74			141,40
Irwin Mitchell	226	203	Elite 3E	Unknown	Unknown	Tessian	1,00	225,92			136,04
DLA Beachcroft	204	199	Elite	Unknown	Unknown	Leverton + iManage	4,00	204,44			111,96
DWF	197	194	Elite 3E	Unknown	Unknown	Unknown	4,00	196,88			100,58
Osborne Clarke	194	142	Elite 3E + Intapp	Unknown	Unknown	Unknown	4,00	194,18			92,10
Addleshaw Goddard	193	171	Elite	Kira Systems	Kira Systems	Kira Systems	3,00	193,31			85,68
Withers	169	123	Elite	Unknown	Unknown	Unknown	4,00	169,36			84,98
Stephenson Harwood	162	121	Aderant Expert	Unknown	Unknown	Unknown	4,00	161,64			74,32

This data is also included in Table 19 in the appendix. Once the data was classified into the four groups per the above criteria, an ANOVA was conducted in R Version 3.3.2 to test the hypothesis and establish if there was a significant difference in a firm's average revenue based on their strategic use of an LCS. While there were some outliers, it was decided not to delete these due to the small size of the data set and since the data was referred to as the UK Top 50. The Leaders group was also relatively small.

3.6 Results

This research sought to establish how law firms make decisions by combining data, technology, and people as a bundle of resources and capabilities to enable decision-making.

The hypothesis was that there is a significant difference in a firm's average revenue based on their strategic use of an LCS.

This explanatory study represents the first quantitative component. This section was grounded on RBT, specifically CRBT. A process was developed around LCSs as strategic (effective) and operational (efficient) capabilities enablers of profitability and competitiveness by Gartner (Vincent et al., 2021).

To test the hypothesis and establish if there was a substantial difference in a firm's average revenue based on their strategic use of a Low Code Platform, an ANOVA was conducted in R Version 3.3.2. Before this, a box plot was run to determine any apparent skewness of the data as indicated in Figure 3.

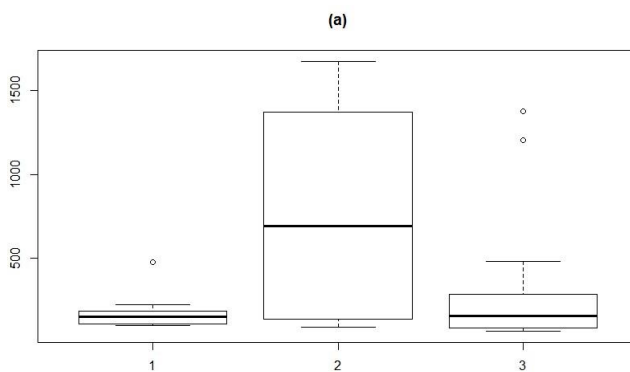


Figure 3: Box Plot of three groups based on the Gartner report (Vincent et al., 2021).

Not assuming equal variances between the groups, a one-way ANOVA was used to test the hypothesis and had a p-value of 0.01698, which was significant at the 5% significance level. Therefore, the null hypothesis was

rejected, concluding that the groups with different LCSs have different means. The mean of the Top 50 UK legal firms in £ Million was 378.4025. Table 3 reflects the means relevant to this research:

Table 3: Average Revenue Top (2015 – 2018) Gartner’s LCP classification.

	n	Average Revenue 2015- 2018 £ Million	Standard Deviation £
Leaders (1)	7	190.8014	152.80
Niche Players (2)	14	736.8150	691.59
Unknown (3)	29	254.9170	159.22

3.7 Discussion of Quantitative Study Results

This minor quantitative research study sought to establish which legal technology implementations impacted decision-making and competitiveness. Niche Player systems are often good choices for their specific environment as the Legal landscape has unique functional requirements, and automating processes enhances their capabilities. It must, however, be noted that the Leaders group had a high standard deviation, indicating a relatively high variance in the financial performance within the group. In contrast, the Niche players had the highest average revenue in earnings, pointing to the importance of repetitive process automation and industry-specific systems that addressed strategy. This suggests that execution and vision are complementary capabilities, amplifying firms' profitability with low code systems as a primary resource. However, as seen in the Niche Players, good process automation and niche flexibility have the most decisive influence. The research, therefore, focused on process automation and flexibility and LC systems in sequential qualitative research to deepen understanding of these complex processes.

Legal firms implementing niche LCSs significantly improved their BDA, enhancing overall firm performance and decision-making through efficient operational abilities. Niche player systems generate more revenue as they specialize in legal environments, where unique functional requirements and process automation are critical for enhancing capabilities and performance, introducing a third dynamic, flexible capability dimension. In the generic area, Niche Players do not have such a significant advantage as customization, and quick, flexible, configurable customization is not such a significant requirement. In specialized areas like legal, where many rules are specific, such as the Solicitor's Account Rules, the generic Enterprise Resource Planning systems do not meet the requirements. They must be customized, making flexibility key.

Visualized flexible workflows improve performance, data security, accuracy, and reliability by addressing inefficiencies in current processes. Automated budgeting systems with assumptions have been linked to higher investment returns (Nikulina, 2020).

In Gartner's study, Vincent et al. (2021) referred to strategic and operational decision-making as dimensions of success. Strategic decision-making or completeness of vision involves setting a firm's long-term direction and scope by making decisions that shape its overall aim and objectives. High stakes, complexity, and long-term implications characterize it. Strategic decisions often involve selecting the right markets to compete in, allocating resources, and determining the firm's priorities, which can be linked to effectiveness (Lampel, 2018; Eisenhardt and Zbaracki, 1992).

Operational decision-making, or the ability to execute, focuses on the day-to-day activities required to run a firm efficiently. These decisions are typically short-term and aim to optimize processes, improve efficiency, and solve immediate problems. Operational decisions ensure that the firm's strategic goals are implemented effectively daily. Strategic and operational decision-making have been conceptualized and researched with

knowledgeable strategic decision-making as the strategic capability (Akter et al., 2016). This decision-making must be timely, accurate, and strategic to support planning and enable forecasting (Frey, 2021).

The research focused on LCSs as the primary resource, supported by two complementary capabilities: (1) their ability to execute efficiently, including implementation and current operational capabilities, and (2) their completeness of vision, strategy, and potential capabilities (effectiveness) (Vincent et al., 2021). The research argues that LCS capabilities increase firm profitability through the sensemaking of large amounts of data that enable actionable strategic decisions. The combination of execution capabilities and visionary potential enhances profitability by processing extensive data for informed strategic choices. However, the model developed by Gartner (Vincent et al., 2021) did not include flexibility in a rapidly changing and complex environment. This research found that with its flexible workflow systems, niche market software allowed more agility in a changing environment. This could explain why the niche market software performed better than expected. As a result of this, the research focused on flexibility, or dynamic capability, going forward.

Dynamic capability is enhanced through technology used for decision-making. Niche systems, specifically workflow systems, provide dynamic capability and enhance decision-making.

The research recognized a third axis, dynamic capability, as illustrated in the visual below, which is enhanced through visualization and influences profitability. This flexible capability of a firm or firm to react to the environment around it and improve its operational efficiencies could explain why the niche systems performed better than expected in the quantitative study.

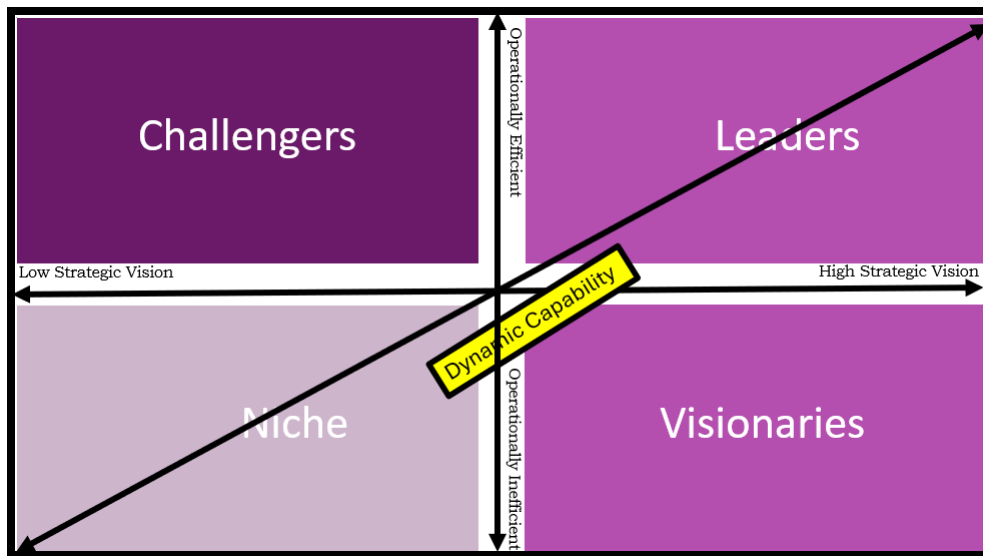


Figure 4: Gartner LCS Classification Enhanced with 3rd Dimension of Dynamic Capability.

This research's inclusion of the dynamic capability axis as a third dimension is illustrated in Figure 4. The dynamic capability of knowledge can be automated through visualization, enabling firms to make actionable decisions by interpreting heat maps and refining budgeting assumptions (Rodrigues, Franco, Silva, and Oliveira, 2021). This iterative process reduces variances and improves accuracy. Agility and flexibility (i.e., how well the LCS has been leveraged in terms of its analytical and report-generating capability) manifest as a dynamic capability.

Niche workflow systems, such as Intapp, visualize the steps in a workflow, and these are easily customizable, providing the firm with a powerful tool to react to a changing dynamic environment. Visualizing the pipelines of these different steps or flows and the associated analytics allows the firm to streamline processes and eliminate bottlenecks. Visualization is therefore crucial in extending contingent operational abilities and adding dynamic capabilities to the bundle, thereby increasing a firm's competitiveness. It facilitated KS, process transparency, and validation. It emerged from the

study as a dynamic capability that could explain why operations and efficiency played a role in a firm's competitiveness. Niche systems with operational efficiency were contributing towards profitability. Wright, Dunford, and Snell (2001) divided the areas of core competencies into Dynamic Capability (processes to integrate, reconfigure, gain, and release to match and create market changes), KM (Knowledge, Transfer, and Integration), and Intellectual Capital (Human, Social, and Organizational). The next step for the research was to explore data visualization more deeply.

3.8 Summary

The quantitative study investigated which types of information technology (specifically information systems supporting decision-making) contribute to the competitiveness of a firm. RBT and CRBT underpin the research. Visualization emerged from the Explanatory study as a dynamic capability that could explain why operations and efficiency played a role in a firm's competitiveness.

It was concluded that legal firms implementing niche LCSs most successfully enhanced their BDA and RPA capabilities. Furthermore, they concluded that efficiency and effectiveness are required for LCSs to be used successfully in the market. Visualized automated workflows can facilitate KS with others in the firm, improving performance, data security, accuracy, and reliability, as well as addressing inefficiencies in current processes.

CHAPTER 4 LEVERAGING VISUALIZATIONS WITH SYSTEMS

4.1 Introduction

CRBT explains and predicts a company's performance and competitive advantage (Barney, Ketchen, and Wright, 2021) by leveraging the firm's resources and capabilities (Kozlenkova, Samaha, and Palmatier, 2014). In Chapter 3, the results of the quantitative study indicated that low code systems (LCS) created a dynamic capability within law firms. Such dynamic feedback systems in decision-making processes have been shown to improve resource allocation (Yang et al., 2021). The results also suggested that the visualization capability of LCS could play a central role in developing this dynamic capability.

These findings prompted the second phase of the research, presented here. Therefore, the research objective of the second phase was to develop a process model of how information systems facilitate human decision-making. This model is based on a review the literature and is complemented by observations and insights from the researcher's twenty-five years of experience in implementing financial systems. This chapter focuses on process automation, flexibility, and LC systems, which became evident in the quantitative research, to deepen understanding of these complex processes. The literature review presented in this chapter explains how people, data, and technology interact to form a bundle of resources and capabilities that support actionable decision-making through visualization.

To begin with, a new process model of organisational KS, was developed, including data and technology, more prominently. To initiate the literature review for the construction of the process model, the Web of Science was searched using the following terms: "data decision-making systems" and the "knowledge management process" and "strategic management" (not

“environment”, “medicine”, and “engineering”), resulting in 76 publications. Figure 5 reveals that most of the citations and publications have increased since 2019, when this PhD study started.

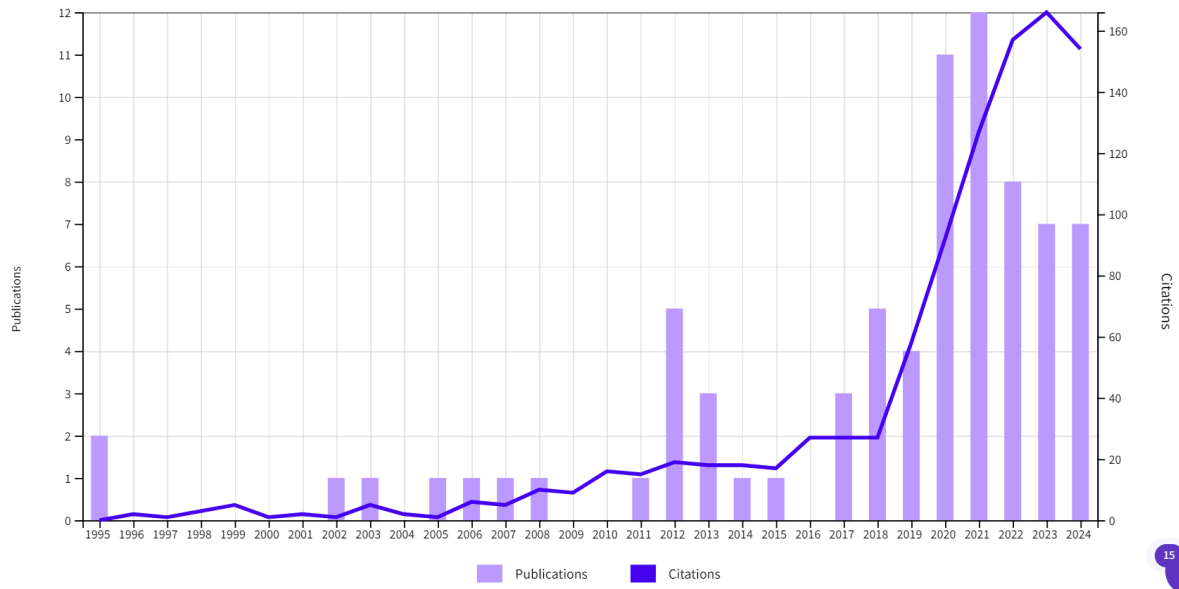


Figure 5: Number of citations and publications since 2005 related to decision-making and knowledge management in strategic management (Web of Science, 2024).

An analysis of the areas of science in which these publications are found, Figure 6, revealed that most are in management and business. These articles dealt with the role of technology, culture, and the environment in KS, but new and emerging technologies have recently impacted the process. This research focused on documenting the stages in the process that need to be modelled in management, business, and operations research.

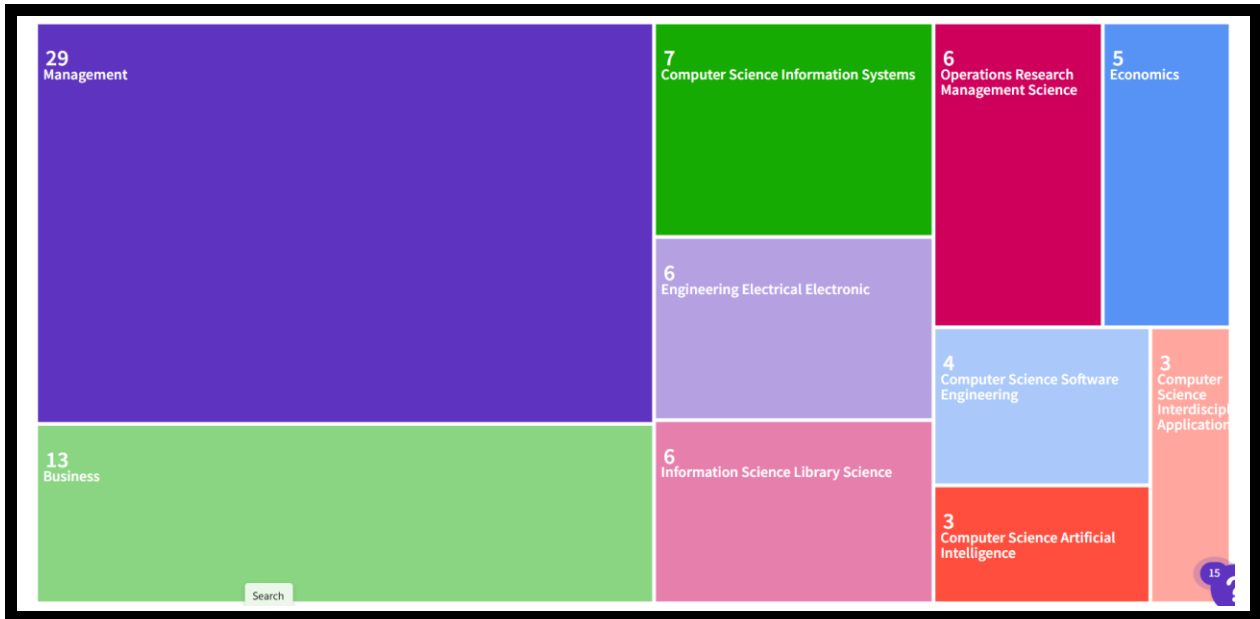


Figure 6: Web of Science categories (Web of Science, 2024).

The Socialisation, Externalisation, Combination, and Integration (SECI) process is a framework within KM, first developed by Ikujiro Nonaka (1994) and also informed the construction of the model. The SECI process is used in knowledge creation, sharing (KS), and management (KM). Knowledge creation refers to the collaborative construction of knowledge, while KS refers to exchanging an employee’s knowledge, skills, and experience (Nonaka, 1994). KM refers to identifying, organizing, storing, and disseminating information within a firm (Nonaka and Ikujiro, 1994). The SECI model (Nonaka, 1994) emphasizes the conversion between tacit and explicit knowledge. Figure 7 illustrates the movement of knowledge from tacit to explicit knowledge and then explicit to explicit. Finally, explicit knowledge moves back to tacit knowledge.

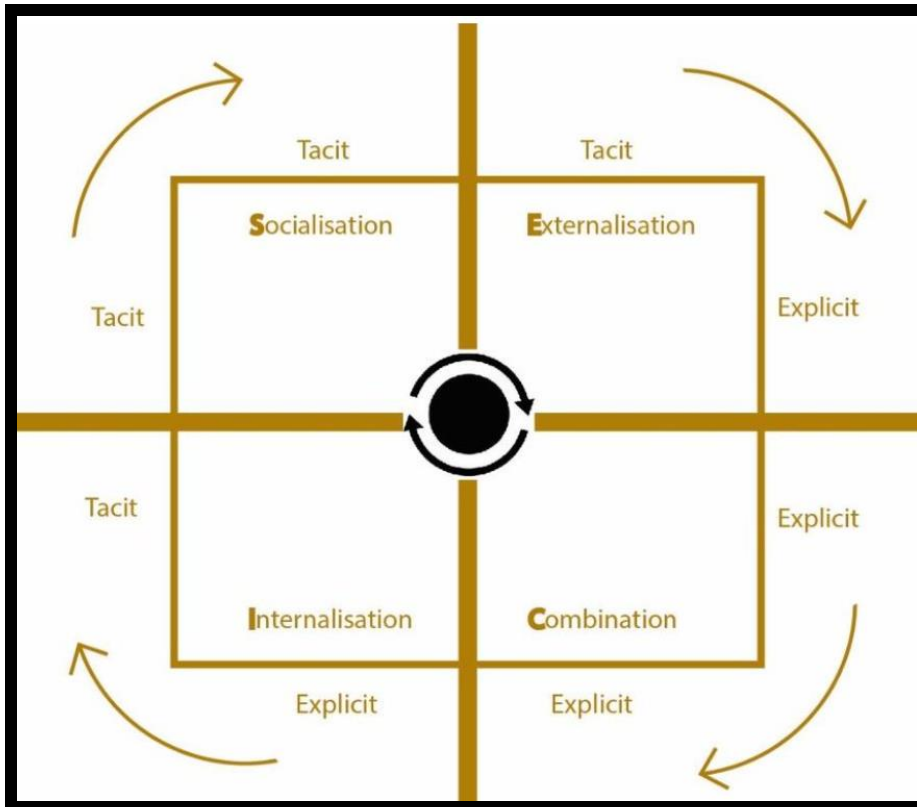


Figure 7: SECI cycle (Bresciani and Eppler, 2009).

Since its introduction in 1994, the SECI model has been expanded to explore knowledge creation in various contexts, such as innovation management, organizational learning, and information systems.

Nonaka, Toyama, and Konno (2000) introduced the concept of "Ba" (shared context) as a dynamic platform for knowledge creation, integrating it with the SECI model to emphasize the importance of context in the knowledge creation process. Adesina, Olaitan, and Ocholla (2019) analyzed KM frameworks between 1995 and 2015 and found the SECI model prevalent.

The SECI process primarily focuses on dynamic interactions between implicit and explicit knowledge between individuals and groups. Some critics observe that it overlooks culture, technology, and the volatility of the

external environment. Bratianu (2018) believes that SECI should be expanded to consider these factors. Adesina and Ocholloa (2019) found that earlier studies focused more on face-to-face interaction, especially during socialization. Technology has enabled hybrid and virtual interaction across geographical and cultural boundaries. The most recent financial transformation projects this researcher has been part of, have all relied on virtual collaboration. Occasionally, onsite meetings are held with people knowledgeable on a topic. Still, even these have a virtual aspect as most attendees are not in the room and are attending via virtual meeting technology. Attendees are from various backgrounds and represent most time zones. Adesina and Ocholloa (2019) purport that SECI must address regional cultural differences adequately. Sian Lee and Kelkar (2013) suggest that SECI ignores the volatility of dynamic environments, and Rubio, Llopis-Albert, Valero, and Besa (2020) state that SECI ignores technological advancements and a changing environment. SECI also focuses on an individual or group level rather than at a global firm level. SECI focuses on people as a strength, but Rice and Rice (2005) stressed that an over-reliance on technology without addressing the cultural and environmental constraints will hinder KS.

Some research focuses on these elements of culture, technology, and the external environment. More recent studies have applied the SECI model to digital and virtual environments. For example, one study examines how technology influences knowledge creation dynamics in research on e-learning and virtual collaboration platforms (Go, You, Jung, and Shim, 2016). In another study, Songkram and Chootongchai (2020) found that IT tools facilitate the sharing of tacit knowledge explicitly and integrate explicit knowledge. Sian Lee and Kelkar (2013) found that video conferencing and social media facilitate KS across geographic boundaries. Tools like wikis and shared documents facilitate documenting explicit knowledge into more structured shareable formats. Information systems support the integration of knowledge, and finally, e-learning platforms and virtual simulations enable the movement back to tacit knowledge.

Cultural challenges such as resistance to sharing and hierarchical structures hinder KS, especially where this could be context dependent. Rice and Rice (2005) warned that norms and attitudes influence tacit KS. Still, a supportive environment with flexible settings facilitates KS knowledge integration, where knowledge moves back to tacit knowledge. In a culture where KS is valued, this supports the flow of tacit knowledge through interactions.

The increasing reliance on technology means that knowledge management processes should integrate emerging technologies and consider the role of cultural and environmental challenges. A knowledge process enabling operational and strategic decision-making consisting of the following sub-processes is now described: (1) Knowledge-Sharing, (2) Knowledge Configuration, (3) Agreement of Global Best Practices, and (4) Knowledge Storage. All four sub-processes are enabled by and interact with an LC system and a knowledge system.

4.2 The Knowledge-Sharing (KS) Process

Lin (2007) concluded that KS is key for enhancing innovation and facilitates the integration of diverse resources leveraging internal capabilities for a competitive edge. KS involves tacit-to-tacit communication and generally passing knowledge through practice, guidance, imitation, and observation (Nonaka, Toyama, and Konno, 2000). Other authors define KS as sharing knowledge and skills for collective problem-solving (Gao, Chai, and Liu, 2018). KS is also seen as an interaction process involving communication and collaboration (Al-Kurdi, El-Haddadeh, and Eldabi, 2018). Others see this as a mechanism for organizational learning enabling the transfer and creation of knowledge (Charband and Nivinipour, 2018). KS could also be defined more generally as the sharing of any knowledge and would therefore feature in all the sub-processes, including configuration, and transformation.

This research focuses on the sharing of tacit knowledge in the first subprocess. It may be counterintuitive that KS of tacit knowledge occurs via technology, which would require explicit rules and assumptions. However, it must be noted that increasingly technology implementation projects are conducted remotely. People with domain knowledge, therefore, illustrate their skills by sharing their screens and navigating their day-to-day activities via systems. Workshops often take the format of one domain expert after another ‘driving’ learning by sharing their screen to demonstrate their domain expertise. Therefore, the link between tacit KS and technology systems can be considered a broken line in that traditional “watch me perform my domain expertise” only occurs in a virtual setting aided through technology tools. Collaborators are demonstrating their expertise using LCS systems such as planning and forecasting systems, knowledge storage systems such as Sharepoint, project facilitation systems such as Kanban boards, and systems such as Jira and Freshservice for logging and managing tickets. This is counterintuitive to the thinking that states that only explicitly documented rules and assumptions can be housed in technology. In this sense, technology is housing or providing the environment for the tacit collaboration, demonstration and sharing of skills to occur too.

According to research, some essential elements supporting KS were organizational culture, leadership support, good technological KS infrastructure, incentivizing KS practices, trust, and having the psychological freedom to share knowledge (Charband and Jafari Navimipour, 2016). Results of selected studies of these essential elements are highlighted, including (1) collaboration, (2) organizational structure and interaction, (3) technology, (4) the interface between people and AI, and (5) the nature of the knowledge shared.

4.2.1 Collaboration

Researchers have focused on KS as a first step in collaborating at the individual, group, and organizational levels. Research in the UK focusing on the corporate sector found that performance is improved by aligning resources through KS systems and collaborative frameworks (Konstantinou et al.,2021). Mahajan, Sharma, Singh, Bresciani, and Alam (2024) employed a survey methodology on the KS habits of middle management concluding that organizational culture and individual motivations affect the collaboration process.

4.2.2 Organizational Structure and Interaction.

KS improves when structured communication channels exist between organizational levels (Thomas, 2024). KS is therefore facilitated through systems that integrate human interaction and advanced digital technologies, as found in the study in Israel, combining human interaction with advanced technology (Nakash and Bouhnik, 2022; Thomas, 2024). They noted that the interplay between formal and informal communication channels required further investigation.

A study set in the professional environment highlighted that collaboration within clusters between the various departments and IT business communication tools improves KS (Ucler, 2017; Joachim, Beimborn, and Weitzel, 2013). Ucler (2017) stressed geographical and cognitive proximity, while Joachim, Beimborn, and Wetizel (2013) found that Service-Oriented architecture aided information technology flexibility, facilitating KS across departments. Pires, Goldstein, Molfino, Ziemer, Orr, and Jiménez (2024) focused on KS in a dynamic multi-level organization and found the emergence of informal structures and behaviours, while Santhose and Lawrence (2023) studied KS at the organizational level citing frequent and

bi-directional communication as being key. Both studies supported synchronous and asynchronous clear, transparent, and flexible knowledge channels.

Research has also shown how organizational structure and social interaction affect KS. In examining organizational structure, Argote and Ingram (2000) focussed on KS within firms, analyzing how internal structures and social interactions facilitate or hinder their synthesis across multiple industries. Anand and Dumazert (2022) investigated how KS practices have evolved globally across various organizational settings, highlighting the fragmentation in KS research and the need for more unified approaches to understanding how knowledge is created, shared, and utilized for organizational performance (Anand and Dumazert, 2022). In another study, Patel, Rammal, Ferreira, and Prikshat (2021) examined KS in cross-national teams within the service industry, particularly in Indian IT multinational enterprises operating in Australia and focused on KS from headquarters to subsidiaries using the onsite-offshore business model, emphasizing two-way interaction and local knowledge creation. Minbaeva and Michailova (2004) researched the role of expatriates in knowledge transfer within multinational enterprises, arguing that expatriates help transform tacit knowledge, emphasizing the importance of global mobility in effective KS (Patel et al., 2021).

4.2.3 Technology

Colnar, Radević, Martinović, Lojpur, and Dimovski (2022) deduced that information communication technologies affect knowledge creation and sharing, as communication technologies act as moderators, enhancing the positive effects of knowledge processes on the quality of healthcare services.

Technology enables KS. For example, research shows that KS is facilitated through knowledge portals and digital tools that enable employees to exchange information quickly, as was highlighted by the study in the knowledge-intensive industries in the corporate sector (Sousa and Rocha, 2019). Technology also facilitates this structured collaboration in that, for example, Agile work structuring boards such as Kanban will be structured in a certain way with conversion and integration sections of the project reporting in earlier bands, according to their position on the board. At the same time, training and change management would be the focus later, the order trying to mirror the order of the activities in the natural program implementation cycle. Scrum masters are taught to use the software universally, ensuring program consistency. Charband and Jafari Navimipour (2016) found that computer-mediated technology, such as Slack, Teams, online forums, and knowledge repositories, was critical in collaborative environments.

4.2.4 Interface between People and AI

AI-powered platforms and the IOT facilitate inter-organizational knowledge exchange and enhance KS, as found in studies focused on AI platforms and IOT in Brazil and Italy (De Bem Machado, Secinaro, Cala, and Lanzalonga, 2022) as well as firms undergoing digital transformation (Venkitachalam and Schiuma, 2022). The role of humans should be expanded and explored in conjunction with AI and machine learning. Ethical implications, biases, security, and privacy challenges should also be focused on. Both studies found that we should concentrate on KS occurs through digital systems and transactive memory for decision-making in the context of cognitive structures enhancing UK corporate acquisitions focusing on efficiency and performance (Lou, Bauer, Samba, and Shepard, 2024) as well as cybersecurity measures in the US (Obitade, 2022; Yan, Hong, and Warren, 2022).

4.2.5 Nature of the knowledge shared.

The nature of the knowledge shared to support decision-making has also been highlighted. Severgnini, Vieira, and Cardoza Galdamez (2018) conducted a study in Brazil in the manufacturing sector, concluding that resources are optimized when cross-functional teams are aligned and consensus on their performance metrics is achieved. Tessema et al. (2017) studied Ethiopia's government agencies and public institutions, finding that once performance measures are agreed the performance metrics' results can be converted to actionable strategic insights.

This KS configuration process supports the collaborator's operational objectives. Operational objectives, in turn, facilitate their strategic objectives. In some areas, their operational and strategic goals are aligned.

As a result of all this collaboration, the participants worked towards structuring their rules and assumptions so that these could be explicitly communicated. This is the next stage in the process.

4.3 The Knowledge Configuration Process

The tacit knowledge from the KS process is converted through further communication into explicit knowledge. This shared explicit knowledge consists of a set of assumptions and rules that guide the configuration of the financial system and inform operational decision-making.

4.3.1 Collaboration

A mode of complexity reduction, sensemaking of ambiguous data, and a structure to order and sequence the process, thus reducing errors, is required (Bresciani and Eppler, 2009; DeCanio, 2016). In this research, the phase during which assumptions and workflow processes are configured involves tacit-to-explicit communication in documents, frameworks, procedures, and configured systems, workflows, and rules.

Their role is to agree and operationalize planning assumptions, ultimately used in the strategic forecasting function. The Gartner (Vincent et al., 2021) study established strategic vision (effective) and operational execution (efficient) in financial decision-making as key to the success of multinational legal entities' decision-making. The quantitative research presented in Chapter 3 established that this Gartner model needs a third dimension of dynamic flexibility to enable success in decision-making within the legal environment.

Collaborators must adjust, realign, recognize new threats and opportunities, and adapt to technological opportunities. Strategic flexibility and the ability to adapt to a changing environment through improved decision-making, often enabled by workflow and dynamic flexibility, allow collaborators to configure processes quickly.

4.3.2 Organizational Structure and Interaction

The configuration knowledge process for decision-making is influenced by domain knowledge and IT unit structure (Yang et al., 2024; Ranganathan and Sethi, 2002). Yang et al. (2024) found that how the IT unit is structured, organized, resourced, and enabled technologically, influences how the knowledge is configured in strategic and operational contexts. Likewise, Ranganathan and Sethi (2002), based on their study in the US, found that aligning IT structure on domain expertise improves the knowledge configuration process and, ultimately, decision-making.

4.3.3 Technology

Assumptions need to be housed in an LCS (Frank, Dalenogare, and Ayala, 2019; Vincent et al., 2021), enabling the exploration and verification of the assumptions. Di Vaio, Palladino, Pezzi, and Kalisz (2021) studied sectors that focus on knowledge integration and sharing with external stakeholders in the technology and service sectors and found that integrating big data helps the company acquire and share knowledge with the external environment, driving collaboration and innovation.

4.3.4 Interface between People and AI

Intelligent automation and ML have recently emerged as key technological innovations driving efficiency, augmenting human capabilities, and transforming industries (Davenport, 2014). Firms employ BDA and Robotic Process Automation (RPA) to automate repetitive processes and to predict and conclude from the data. Unusual activity and bottlenecks are detected, processes are streamlined, and tasks are managed (Neirotti and Paolucci, 2007; Rivard, Raymond, and Verreault, 2006). An Enterprise Cognitive Computer (ECC) refers to those applications that include machine learning to streamline firm processes (Tarafdar et al., 2017) through increased efficiency and productivity, leading to improved decision-making and scalability (Neirotti and Paolucci, 2007; Rivard, Raymond, and Verreault, 2006; Tarafdar, Beath, and Ross, 2017). Intelligent automation combines artificial intelligence, machine learning, and easy-to-use interfaces, enabling more efficient work processes (DeCanio, 2016). There are three stages of automation, namely data acquisition and analysis, decision-making, and action implementation (Balfe, Sharples, and Wilson, 2015).

The following studies covering technology and business management sectors set in Italy, Croatia and China all found that knowledge is configured through data-driven AI algorithms that create insights from vast datasets (Abbate, Centobelli, Cerchione, Oropallo, and Riccio, 2023; Erceg and Zoranović, 2022; Wang et al., 2020), making it more intelligent and more efficient and often includes streamlining operational workflows and removing redundancies (De Bem Machado et al., 2022). Fuzzy logic and visualization algorithms configure systems to enable decision-making (Krasnyuk et al., 2022; Moretto, 2022). The studies in Russia and Italy found that fuzzy logic allowed progression from binary true or false decisions to reflect real-world decision complexity more accurately.

Patel et al. (2021) recommend further configuration process research using AI and ML, particularly in global cross-functional teams where the complexity of KS is amplified. The application is well suited to environments where the assumptions are complex, and it is difficult for a human to process all iterations manually. Additionally, there is scope to investigate the role of knowledge configuration in firms transitioning to digital-first business models and the impact of real-time data analytics on decision-making processes.

4.3.5 Nature of the Knowledge Shared.

Data-driven decision-making was emphasized by Becerra-Fernandez and Sabherwal (2014), who conducted their research in technology and consulting companies in the US and stressed the importance of data-driven knowledge flows, and Shabbir and Gardezi (2020) who conducted their study in Pakistan and found that a data-driven knowledge approach aids with configuring knowledge systems that enhance decision-making.

Expert support system inputs and configuration should align with performance indicators to ensure alignment on desired outcomes and decision-making (Severgnini, Vieira, and Cardoza Galdamez, 2018; Liberatore and Stylianou, 1995). A multiple-criteria supplier segmentation using outranking and value function methods is used to configure performance criteria based on company-specific databases (Segura and Maroto, 2017). This research was set in Spain to assess performance criteria for supplier segmentation using company-specific databases, categorizing suppliers according to their quality, reliability, and cost-effectiveness, effectively allowing them to make enhanced procurement decision-making through configuration.

Nikulina (2020) conducted a study on corporations in Russia and found that firms with explicit budget assumptions improved their resource allocation and, ultimately, their investment returns. In a study in Spain focusing on the manufacturing and service industries, Sanchis et al. (2019) found that codifying and storing the planning assumptions of SMEs and SEs and housing them in technology-enabled strategic and operational decision-making. Müller et al. (2018) conducted a study in Germany with technology and business companies and found that housing-configured assumptions enable decision-making. Vincent et al. (2021) focused on the healthcare system in the UK and explored KS and knowledge configuration practices intending to improve decision-making and, ultimately, patient care.

Data is transformed using predictive models and analytics to provide insights and anticipate risk (Zahay and Peltier, 2008; Chen et al., 2024). Zahay and Peltier found that customer relationship systems in the US were better configured when data was analyzed to understand and forecast trends to improve customer interaction and enhance return on investment.

The assumptions and explicit workflow steps are housed in LCS systems. For example, Tagetik is an example of a planning and forecasting system. Documents outlining the configuration are found in Sharepoint, and such documentation is attached to ticket management systems as supporting documentation.

Codifying knowledge into accessible systems enhances decision-making and operational efficiency. Systems must be configured to understand customer behaviour better, leading to strategic decisions (Ivanov et al., 2023; Day et al., 2007). Team knowledge configuration and structuring the knowledge leads to optimized performance if goal misalignment is addressed (Pereira De Souza et al., 2021; Franke, Foerstl, and Heese, 2021). This cycle can run iteratively to agree assumptions and steps with different regions, offices, practice areas or products. Once the knowledge has been codified collaborating teams must agree on best practices.

4.4 Agreement of Global Best Practices

In this case study, the process being studied is establishing best practices from the configured process flows and assumptions of the financial system at the corporate level or across its regions and firms. This phase combines, consolidates, and transforms knowledge into new best practices and working methods. The following literature underpins our understanding of changing knowledge and sharing best practices.

4.4.1 Collaboration

Collaboration across the business and a single database provide visibility and control of corporate data to address multiple stakeholders, aggregating results and comparing new insights. Regions, offices, products, practice areas, etc., come together in workshops (virtual, onsite, or a mix of both components) to agree on best practices. Best practice entails linking data analysis and decision-making frameworks to inform long-term success. Transformation happens through continuous real-time improvement cycles that apply and modify knowledge (Erceg & Zoranović, 2022). The Erceg and Zoranović (2022) study in Croatia determined that establishing best practices is iterative and involves feedback loops. This supports dynamic learning and adaptation in an evolving context.

4.4.2 Organizational Structure and Interaction

Charband and Jafari Navimipour (2016) discovered that knowledge relevance, accessibility, cross-functional collaboration, training, and awareness improve KS across the organization. Engaging with external expertise and fostering collaborative practices is critical to enhancing shared knowledge and strategic capabilities. Zablith, Faraj, and Azad (2015) explored the challenges of knowledge generation and sharing within firms, particularly as the boundaries between internal and external knowledge blur due to online platforms. They proposed a framework for integrating internal knowledge with external sources using semantic web technologies, emphasizing the importance of organizational collaboration and external knowledge engagement.

In terms of knowledge configuration in remote and cross-national teams, there is a need for two-way knowledge exchange between headquarters and subsidiaries for improved decision-making and organizational performance, and the KS processes could be enhanced by allowing more autonomy at subsidiary levels (Patel et al. 2021). Abuaddous, Abdullah, and Blaqees

(2018) found, in their meta-analysis of the relationship between knowledge management and organizational outcomes, that implementation and agreement of best practices enhance organizational outcomes.

4.4.3 Technology

The study by Liberatore and Stylianou (1995) was set in the corporate and information technology sectors in the United States and focused on including expert systems in the workflow processes to improve performance measurement, decision support, and KS. Performance metrics were also an area of focus.

Oesch, Gillen, and Karnowski (2020) found that ShareAL provided a dashboard mechanism for overcoming the challenges of collaborative data analysis. For example, regarding strategic planning Melović, Dabić, Vukčević, Ćirović, and Backović (2021) conducted a study in Montenegro and found that sharing metrics and strategic plans across departments and between collaborators facilitates the KS process, improving organizational performance. Rice, Martin, Raziq, Memon, and Fieger (2024) deduced that strategic planning and budget monitoring facilitate KS and improve financial performance.

4.4.4 Interface between People and AI

Collaborators in the various regions can, for example, demonstrate the accuracy of their best practice assumptions by utilizing them to generate accurate forecasts. In this way, other regions adopt relevant shared assumptions, and specific assumptions particular to their region only, are highlighted as such. AI is increasingly used to generate multiple scenarios in seconds as various combinations of assumptions and workflow processes

are run through to establish those generating the most accurate profit and loss reports when run with retrospective data from previous years. Further research is recommended by Zablith et al. (2016) to explore how global firms can optimize knowledge transformation processes by leveraging AI and machine learning tools to manage internal and external knowledge flows and encourage autonomy. Additionally, research could focus on developing more interactive KS platforms to enhance real-time decision-making across global teams.

4.4.5 Nature of the Knowledge Shared

Teece (2007) highlights how sensing threats and opportunities, mobilizing resources and capabilities, reconfiguring organizational structure to support decision-making, and strategically using resources in contingent situations improve a firm's success and establish best practices to deal with this changing environment. Furthermore, dynamic resource deployment, strategic flexibility, and the ability to adapt to a changing climate make firms more competitive, so firms should train their staff and invest in flexible systems to ensure dynamic capability (Teece, 2016). Performance and product data must be transformed into firm capabilities or decisions (Severgnini et al., 2018; Liberatore and Liberatore, 1995).

In the researcher's experience regarding the knowledge process, strategic and operational financial decision-making is enabled by agreeing and applying best practices within and across large multinational legal firms, regional offices, and practice areas. Once these best practices have been established and underpin operational and, ultimately, strategic decision-making, these established assumptions, methods, and other forms of knowledge must be housed in knowledge-based systems and the planning

and strategic LC systems. Within a more significant financial transformation, one region may agree and make explicit assumptions within their region, while another region may agree on best practices or work on their knowledge storage or governance. This could be true across practice areas or products, too. Cycles of agreeing best practice could be iterative.

4.5 The Knowledge Storage Process

Central to the knowledge storage process is accepting and incorporating new ways of working and ensuring effective governance. Further communication of best practices in the workflow process leads to them being assimilated into corporate policies and the creation of a shared knowledge base.

4.5.1 Collaboration

The stored knowledge is a repository of best practices, policies, insights, and historical data to enable collaborators to make informed decisions. Once the structure of such repositories is agreed upon during the best practice process, the collaborators work together to decide and upload policies, training documents, and other ticket system documentation supporting specifications, risks, change requests, tests, or other forms.

4.5.2 Organizational Structure and Interaction

Shared repositories of best practices and policies tend to be a hallmark of a mature organization. Governance procedures and post-program audits

inform future programs regarding lessons learned and improving future cycles.

4.5.3 Technology

Knowledge bases are used to assimilate and adopt visualizations from one implementation for future implementations. However, this knowledge repository is dynamic because data is constantly being added to the database and analyzed by collaborators using LC systems. The resultant policies, processes, and configurations are shared in the KM system, for example, in Sharepoint. Lessons learned are often stored in ticket-based systems such as Jira, informing future programs are regional implementations. Storytelling with technology as the enabler facilitates this process (Ajma and Koskinen, 2008) in project-based organizations. These policies inform operational and, ultimately, strategic decision-making.

4.5.4 Interface between People and AI

Predictive models in strategic management allow for not only the storage of knowledge but also the anticipation of future scenarios, allowing alignment with future trends and a competitive edge in a complex environment (Iscaro et al., 2022).

4.5.5 Nature of the Knowledge Shared

Data is stored in models or interactive databases for future use (Moretto et al., 2022) and in visual repositories to facilitate operational tracking in real-

time construction projects (Nahangi and Haas, 2014). Information is stored through system tracking and governance models (Joachim et al., 2013). System tracking related to monitoring data flow is required for compliance, monitoring, and accountability.

According to Becerra-Fernandez and Sabherwal (2014), knowledge is built on extracting value from a large variety of data and information sources to make management decisions or spot anomalies, resulting in sustained competitive advantage.

Finally, in the knowledge process, the new knowledge in the knowledge base and governance must be accepted and incorporated by returning explicit knowledge to tacit knowledge. A learning culture facilitated by storytelling and after-action reviews internalizes knowledge. Narazaki, Chaves, and Pedron (2020) highlight how organizations can internalize explicit knowledge into tacit through continuous learning and embedding a learning culture. Regarding the environment Charband and Jafari Navimipour (2016) found that low staff turnover and clear policy articulation related to KS and informal structures facilitate KS. Ahadzie, Proverbs, and Olomolaiye (2008) create an environment that encourages experiential learning and allows users to absorb and apply knowledge. Assumptions linked to various regions, offices, products, and practice areas can be stored together with scenario iterations and cycles to iteratively agree, document and store these, together with the governance of these.

Compared to the other areas of the knowledge process, there are fewer studies on storing and retrieving knowledge relating to enhanced decision-making. However, it is understood that storing such knowledge supports operational and, ultimately, strategic decision-making. It is also understood

that this process is iterative. For example, stored knowledge is utilized to implement the next office, region, or product.

4.6 Model of the Knowledge Process

In reviewing the literature above, this research developed a new knowledge process model. Landry (2006) presents a conceptual framework called the "knowledge-value chain" to improve KM and its application in public health firms. It identifies five key capabilities—mapping and acquisition, creation and destruction, integration and sharing/transfer, replication and protection, and performance innovation—critical for translating knowledge into actionable insights for health systems. This research, in contrast, developed a knowledge process model including sharing, configuring, agreement of best practices, and storage of this knowledge, as depicted in Figure 8, depicting the leveraging of LCS systems to facilitate strategic and operational decision-making. The LCS underpins this, for example, a planning and forecasting system like Tagetik, and the data is in the form of assumptions and related fields such as realization, billing, collection cycles, etc. This is additionally underpinned by the knowledge management system, which houses shared policies and best practices, such as Sharepoint.

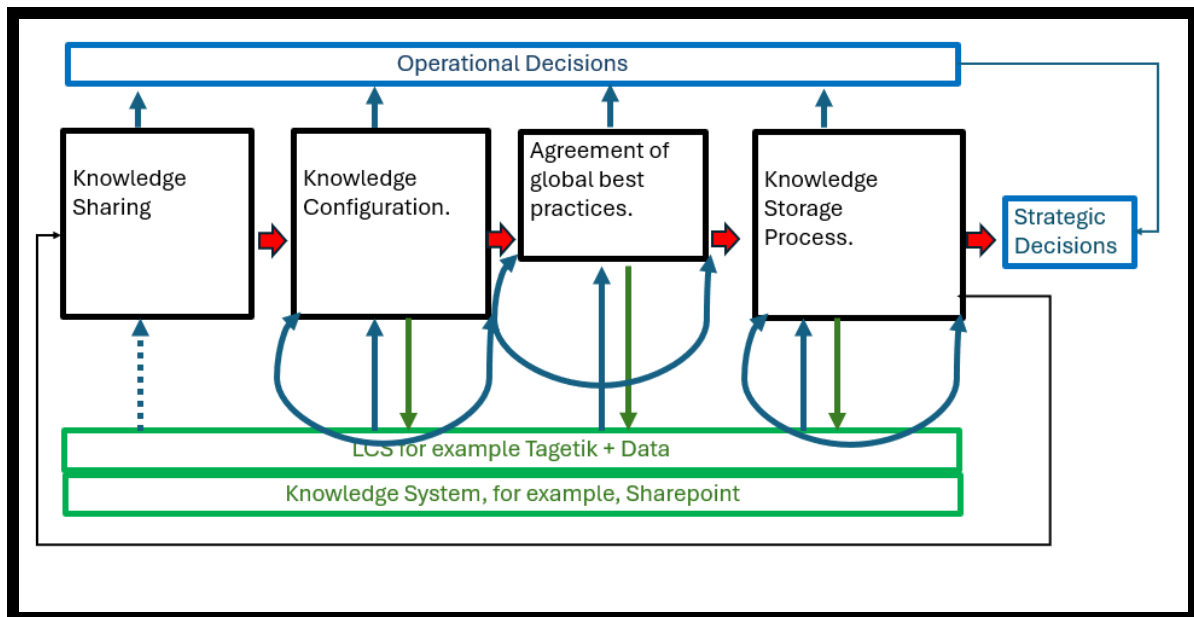


Figure 8: Knowledge-Sharing Process Enabling Operational and Strategic Decision-making.

This KS model is the outcome of the literature review combined with insights from the researcher’s twenty-five years of financial transformation experience. The individual steps are well-researched and cited but have been combined to develop the model. In the previous chapter, the Gartner model was amended with the addition of dynamic capability, referring to the extent to which visualizations are leveraged. This KS process enables decision-making but is silent on visualizations’ role in decision-making. This will be investigated further in the next section.

4.7 The Role of Visualization in the Knowledge-Sharing Process

Based on the KS Process model presented in Figure 8, the role of visualization in the KS process is now considered. KS occurs through structured communication channels between organizational levels (Thomas, 2024) and is facilitated through systems integrating human interaction and advanced digital technologies, as found in the study in Israel combining

human interaction with advanced technology (Nakash and Bouhnik, 2022; Thomas, 2024), however, the role of the unfolding relationship in the light of further development, needs to be explored. AI-powered platforms and the IOT facilitate inter-organizational knowledge exchange and enhance KS, as found in studies focused on AI platforms and IOT in Brazil and Italy (De Bem Machado, Secinaro, Cala, and Lanzalonga, 2022) as well as firms undergoing digital transformation (Venkitachalam and Schiuma, 2022).

The SECI model (Nonaka 1994) emphasizes the conversion between tacit and explicit knowledge but focuses on verbal and written knowledge exchange methods. Regarding visualization's role as a tool for knowledge conversion Weck, Humala, Tamminen and Ferreira (2022) explore the role of knowledge visualization in enhancing collaborative decision-making processes in regional innovation systems. The study uses a socio-technical approach, integrating techniques like cognitive mapping and system dynamics, to develop a framework for supporting knowledge management (KM), Knowledge-Sharing (KS), and knowledge collaboration (KC). Emphasis is placed on visual tools aiding decision-making and knowledge integration.

Holstein, Schemmer, Jakubik, Vössing, and Satzger (2023) explore the development of systems that enhance data understanding through sanitization, involving data preparation for efficient analysis. By providing visual exploration features, these systems enable better data interpretation and storage, aiding firms in extracting actionable insights from complex datasets. Clarke, Mortensen, and Freytag (2023) investigate how firms utilize visualization techniques to enhance customer participation and facilitate KS. The study identifies four key customer participation activities—probing, selecting, mapping, and exploring—supported by visualization, leading to improved service interactions.

Other than the above studies, the gap in the SECI literature is that the visualization role should be expanded on, especially in the light of the merging technology and the interaction required with the domain user and the visualization in the light of complex data in the KS process and its contribution to decision-making and, ultimately, competitive edge (Bresciani and Eppler, 2009). The current research is fragmented (Anand and Dumazert, 2022) and could benefit from focusing on the role of data and technology. While the process has been explored by the aforementioned researchers above, the process needs to be elaborated on. Visualization is increasingly recognized as a valuable tool for KS, primarily when complex data or concepts must be conveyed clearly and quickly (Bresciani and Eppler, 2009).

The fast interpretation of complex concepts and hidden patterns is underexplored in the SECI model's traditional framework, which emphasizes verbal and textual knowledge exchanges, particularly in the externalization and combination phases, where integrating visualization tools into KS processes can help firms better align their KM efforts with practical decision-making needs.

Eberhard (2023) researched how complex patterns identified through visualization may be identified through something other than traditional methods. Padilla et al. (2018) found that visualization allows humans to process information more intuitively and accurately. Diagrams, charts, and heatmaps are powerful tools for sharing and making sense of complex information. This medium also facilitates the sharing and communication of tacit knowledge. Visual tools also speed up the recognition of patterns and trends obscured in a mountain of data.

The KM process research has also focused on operations, medical, and environmental industries. This research applies this to the practice management context central to decision-making in the service industry.

Abbate et al. (2023) needed more research identifying how firms configure knowledge resources in response to dynamic external conditions.

Having established the gap, the KS process is explored regarding visualization. Given the vast increase in literature sources since 2019, visualization's role in decision-making is essential and must be incorporated into the knowledge process model proposed in Figure 7.

4.8 Visualization's Role in Communication, Process Configuration and Workflow Verification

Bradel et al. (2013) and Kumar et al. (2017) confirmed that visualization enables collaborative sensemaking and communication. These visualizations facilitate KS by reducing complexity and highlighting insights supporting decision-making (Allen et al., 2014). Data visualization uncovers hidden knowledge, improves decision-making, and supports strategic planning (Chiang et al., 2018; Obitade, 1920), achieving competitive advantage, unlocking firm value, and increasing revenue (Akter et al., 2016).

Cairó and Dominik Bork (2017) studied the conversion of tacit to explicit knowledge transfer. They found that visual knowledge representation made assumptions and knowledge more explicit, supporting the creation and improvement of products and services through transparency. The visualized algorithms enable SMEs to make sense of the complexity, ultimately improving their operational and strategic decision-making (Krasnyuk et al., 2022; Moretto, 2022).

Wright, Dunford, and Snell (2001) described dynamic capability as processes to integrate, reconfigure, gain, and release resources. This

research considers visualization to be a dynamic capability. Data Visualization is the graphical representation of information and data in charts, graphs, and maps. This makes trends, outliers, and patterns in data obvious. It transforms raw data into a visual context, making complex data more understandable and usable (Chae et al., 2014).

Multi-dimensional scenarios can also be modeled using predictive analytics. Potential relationships or correlations can be depicted by leveraging a pairwise correlation matrix and depicting this as a heatmap. The gradients of the heatmap vary based on the strength of the correlation, and in this way, the relationships are visualized (Gu, Eils, and Schlesner, 2016). Another way is to utilize pair-wise scatter plots to display the relationships between the variables of interest. A third way is to use parallel coordinates representing points as connected line segments. Points close together tend to cluster visually. Two continuous numeric attributes can be visualized using scatter plots and joint plots. Scatter plots visually show where points congregate. Subplots or facets can visualize two discrete categorical attributes. Stacked bars and multiple bars can also depict two-dimensional discrete categorical data. Six dimensions can be presented by removing depth (i.e., no cubed box) and using facets (e.g., fat tummy) and hue to represent the numerical axis. This creates scatter charts with hue, facets, and size variations. Qu and Hullman (2018) described the problem of checking consistency in depicting multiple dimensions as a play-off between constraints and satisfaction and included advice for communicating inconsistencies to users. Figure 9 has various dimensions with position, size, and colour as dimensions.

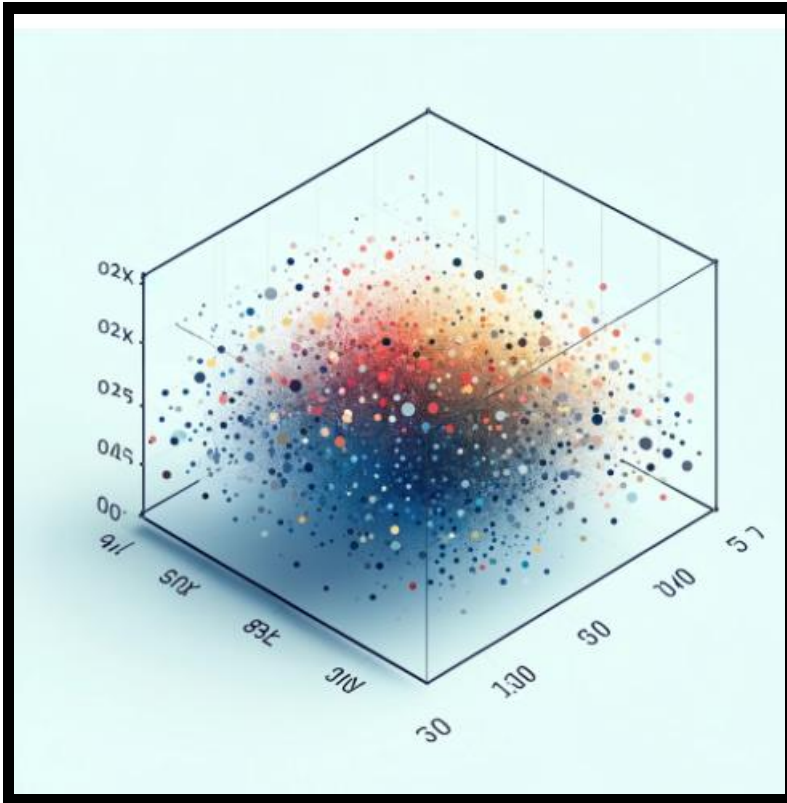


Figure 9: Visualization depicting different dimensions (Open AI, 2024).

Highlighting what is attractive has also been called ‘Flatter-boxing’ and highlights differences. To illustrate how many nodes can be reasonably presented in a network graph using colours like red, green, or blue to convey a sentiment immediately is called ‘simple boxing,’ which has sometimes been criticized for hiding complexity (Song Zhang, Demiralp, and Laidlaw, 2003). Furthermore, clustering is said to convey the underlying patterns of the data; however, the number of dimensions displayed is subjective.

Uncertainty, typically described statistically by calculating the standard deviation, standard error, and confidence intervals, can also be visualized and takes the form of error bars and shaded intervals (Bresciani and Eppler, 2009). When differences are slight, an effective visualization technique is to use a panel or facet (Verdinelli and Scagnoli, 2013).

Billing rules are necessary to sense-make the unstructured and complex billing data (Chiang et al., 2018). It is argued that visualization can facilitate sharing tacit knowledge with other experts, allowing it to be diffused within firms and optimized once made explicit. Visualization can support making embedded and complex tacit knowledge explicit and more accessible, thereby enabling interdisciplinary communication and action. Visualization can assist accounting in billing-related activities. Vague billing descriptions, listing multiple lawyers performing the same task, or having lawyers performing unskilled tasks can result in bill rejections and a diminishing bottom line (Sedera et al., 2016). Unified Task-Based Management System (UTBMS) and Legal Electronic Data Exchange Standard (LEDES) create codes for types of activities or tasks and expenses and provide standardized invoice formats to enable concise billing (Sedera et al., 2016). This assists, as the data is uniform, in data analysis, pattern identification, and grouping of complex data. Dashboards displaying bill statuses, client reduction, and appeal and rejection reasons can lead to improved leverage and billing and collection patterns being revealed and addressed (Sedera et al., 2016).

Octagonal or spider diagrams, with various distances from the center reflecting the different dimensions, can be used to explain the shift from revenue to profitability to partners by, for example, highlighting how write-offs or disbursements (i.e., both hard and soft expenses) that exceed contractual levels are diminishing profits. The visualizations of successful partners, along the various dimensions, can be compared to those less successful from a bottom-line perspective.

Quantitative legal prediction (Katz, 2013), where hundreds of thousands of data points, such as cases, holdings, settlements, quality, cost, and client satisfaction, are trawled in seconds, aids decision-makers in considering operational decision-making, for example, the pricing, longevity, and risk of a portfolio of matters. The relationships can then be depicted using techniques for visualizing the various numbers of dimensions. By predicting the likelihood of winning a case or its perceived complexity through analysis of the previous case points, pricing analysts can suggest pricing strategies appropriate to the case (Ashley, 2017). Pricing analysts can be seated in either accounting or the various practice areas.

Visualization can also assist in accounting practices and decision-making in law firms. Firstly, revenue streams and profit margins can be analyzed. Understanding the drivers of profitability growth will help identify the business units with the highest margins or those requiring cost improvements driven by activity-based costs and billing analysis. Real-time alerts in emails or visualizations using colour or other methods drive actions required by prompting management to interpret the visualizations and translate their understanding into decisions (Familiar and Barnes, 2017). Scenarios could also be evaluated using highlighted threshold variances, and once the thresholds are breached, they can be depicted using colour or trigger alerts.

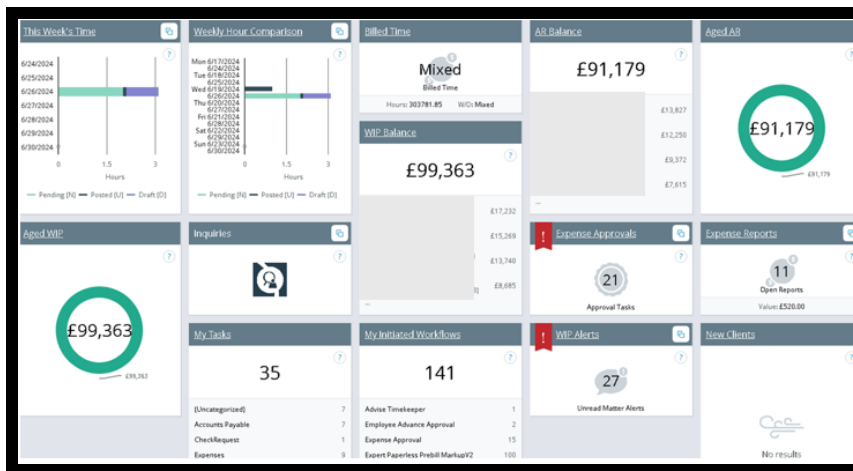


Figure 10: Dashboard Visualization (Open AI, 2024).

As illustrated in Figure 10, management can make actionable predictions by visualizing trends, for example, relating to a client's Work in Progress amounts indicating that a matter should be billed. For instance, if matters are increasingly complex and challenging to win, they must be priced accordingly. However, more straightforward matters must be transparently billed to clients to avoid losing business (Manure, Bengani, and Saravanan, 2023). Utilizing what-if scenarios is critical as clients are becoming more demanding and will move to firms that can provide transparency and motivate their actions with predictions based on predictions (Bhavani et al., 2019)

Strategic data-based decision-making by a multidisciplinary team is enabled by data visualization (Shabbir and Gardezi, 2020). For example, a budget framework is visually validated through a heatmap by comparing the budgeting accuracy and assumption complexity between the different regions where it was implemented. In summary, value is added when developing a new data visualization process, focusing on the role of budgeting assumptions and using planning process visualizations. This approach improves communication efficiency, effectiveness, and understanding of budgeting while enhancing accuracy, leading us to develop our research objectives.

Within RBT, people can improve their competitive advantage through their skills and expert knowledge capabilities. Interdisciplinary communication involves integrating methods, insights, and communication across two or more disciplines to address a topic or problem (Krehbiel, Gorman, Erikson, Loucks, and Johnson, 2001). Data visualization can enable the taking of actionable decisions and act as an interdisciplinary communication, allowing the conversion from insight into action (Coombs et al., 2020; Han, Kamber, and Pei, 2012; Shabbir and Gardezi, 2020). Lurie and Mason (2007) assert that data visualization improves decision-making by leveraging the human ability to visually process complex cognitive patterns and trends.

Visualization is a form of interdisciplinary communication within a multidisciplinary team that facilitates effective collaboration (Huutoniemi et al., 2009) and, for example, the interpreting of statistical results (Padilla et al., 2018; Shabbir and Gardezi, 2020). The visualization seeks to communicate information and, in some instances, to discern and present patterns to provide new insights and inform appropriate action once the primary users understand the patterns (Yi, Kang, Stasko, and Jacko, 2007). This aligns with Lurie and Mason (2007), who assert that data visualization improves decision-making, facilitating information acquisition and integration.

Data insights and their role in communication have been studied in management (Sackett et al., 2006) and marketing (Munoz, 2017) disciplines, as well as information science (Eberhard, 2023). The multidisciplinary team in this case study comprises management, financial, and technical subject matter and system experts. Visual

displays help present inferences and conclusions and represent ways of organizing, summarizing, simplifying, or transforming data.

Through data integration from various systems, interdisciplinary teams can view the data in a unified way, allowing cross-disciplinary analysis and communication. As this information is understandable, it can be shared across a wider audience of stakeholders for decision-making (Eberhard, 2023). Most importantly this visual communication transcends language barriers in a large multi-national project.

Data visualization is understood across many disciplines, including management (Sackett et al., 2006) and marketing (Munoz, 2017), as well as information science (Bresciani and Eppler, 2009; Eberhard, 2023). Visual analytical representation acknowledges boundaries evolving through emergent stages, progressively helping to integrate diverse disciplinary knowledge (Bhavnani, Visweswaran, Divekar, and Brasier, 2019). This enables team members from multiple disciplines to play primary and supportive roles in transforming the visual representation of the data, helping the team to arrive at novel translational insights that can then be shared (Akpan and Akpan, 2021). The role of visualization in CRBT studies is classified as niche and emerging (Bedford and Malmi, 2015).

Visualization presents information or concepts as a mental image to communicate a message (Padilla et al., 2018), aiding clarity and comprehension (Bresciani and Eppler, 2009). Visualization can facilitate sharing tacit knowledge with other experts, allowing it to be diffused within firms and optimized once made explicit. Visualizations typically result from statistical analyses presented in line, bar, and area graphs (Weissgerber, Milic, Winham, and Garovic, 2024). Scatter charts can show the values of

two variables as points, and when used in adjacent windows, practitioners can compare many variables visually and instantly. Maps, indicators like gauges, and tickers can show direction, while pivot tables can summarize and highlight critical data by colour or bullet graphs (which avoid cluttering) (Han, Kamber, and Pei, 2012). Box plots show the data distribution, while matrixes can simultaneously show hundreds or thousands of data points, with colour highlighting the critical points.

Visualization can reveal patterns through design, colour, and typography in graphs, charts, and heat maps. In the workflow process studied, the SMEs and SEs can then, for example, check if the codified planning assumptions result in a more accurate profit and loss heatmap forecast by eliminating the red variances. Visualization enhances understanding and enables more informed decision-making and coordinated actions in firms by making abstract concepts more tangible (Bresciani and Eppler, 2009).

Visualization techniques such as strategic resource maps depict the complex relationships between a firm's resources and the external contingencies that affect their value in strategic resource mapping (López-Rodríguez, Oteros-Rozas, Isabel Ruiz-Mallén, March, Horcea-Milcu, Heras, Cebrián-Piqueras, Andrade, Lo, and Piñeiro; 2023). These maps assist stakeholders in visually grasping how changes in the external environment might influence the firm's competitive advantage. Research has shown that visualizing these relationships can enhance strategic decision-making by identifying the most valuable resources more easily under specific conditions (Gupta et al., 2015). Visualization can support making embedded and complex tacit knowledge explicit and more accessible, thereby enabling interdisciplinary communication and action.

Visualization can be employed in scenario analysis to explore potential future states of the environment and how a firm's resources may perform under these conditions. Using visualization tools like heat maps and dynamic models, researchers and practitioners can better understand how to build dynamic capabilities that respond effectively to changes. This aligns with CRBT's emphasis on the contingent nature of resource value (Helfat and Peteraf, 2003).



Figure 11: Interactive Data Visualization (Open AI, 2024).

As shown in Figure 11, interactive observation allows users to change the inputs dynamically, enabling observation of model reactions or analyzing learned patterns (Heer and Shneiderman, 2012). Rheindorf (2019) stated that interactive visualization linked human reasoning and artificial intelligence through interactive collaboration. Visualization tools can be applied to test hypotheses but could lead the researcher to reject a hypothesis if the desired pattern is not

displayed. In the workflow process the SMEs and SEs can present their domain knowledge thinking and implementation assumptions through visualizations.

Another area where visualization plays a crucial role within CRBT is resource portfolio analysis (López-Rodríguez et al., 2023). Visualization tools such as portfolio matrices can help firms analyze the diversity and balance of their resources to external contingencies. These visualizations can illustrate how well a firm's resources align with different market or technological environments, aiding in strategic resource allocation (López-Rodríguez et al., 2023). Killen, Geraldi, and Kock (2020) investigated whether and how visualizations affect project portfolio decisions. The relationships between internal resources and the external environmental factors affecting their strategic value must be uncovered (Helfat and Peteraf, 2003).

Visualization enables co-located collaborative sensemaking, as evidenced in research by Bradel et al. (2013). In the workflow process studied, the results are visualized in a heat map, charts, or graphs to give insights underpinning future budgets—visualization enhances accuracy by internalizing shared assumptions and previous billing and collection patterns. The enablement of driver-based planning on a unified platform in a single data repository serves the needs of multiple diverse stakeholders, balancing the need for flexibility and simplicity. SMEs and the SEs often use heatmaps to reduce complexity.

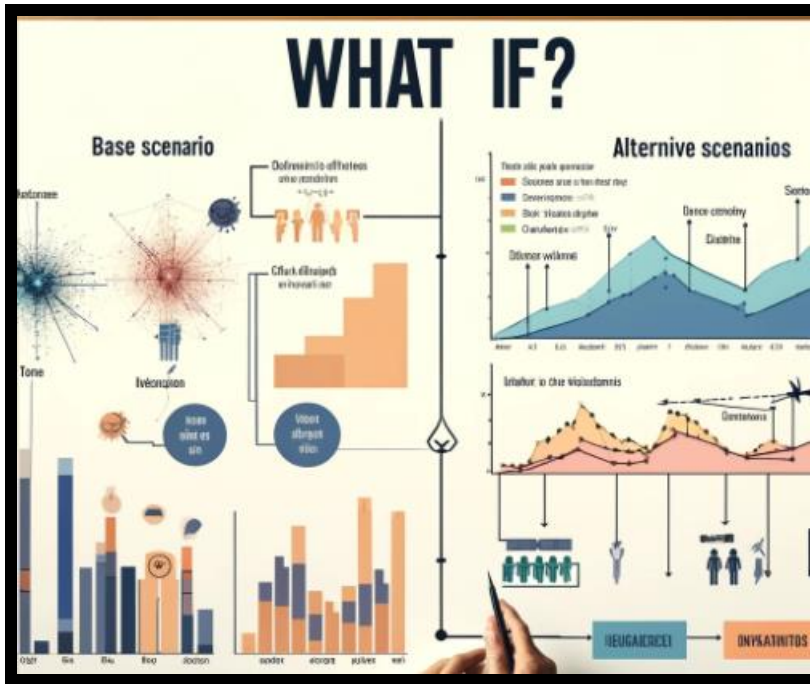


Figure 12: Visualization depicting What-If simulations (Open AI, 2024).

Management can graphically depict and decode real-time what-if analyses, as illustrated in Figure 12. Simulations support decision-making and thereby improve competitive advantage. System dynamics and agent-based simulations created the configuration for strategic decision-making (Sanchez-Segura, Dugarte-Peña, Medina-Dominguez, and García De Jesús, 2018.) Forecasting and scenario planning relate to budgeting assumptions converted into actionable knowledge to direct resource allocation and plan for expansion or contraction in different practice areas, office locations, etc. Visualization aids resource planning through interactive maps and real-time data visualization for policymaking (Kyem, 2021). BDA is visualized into geographic maps to transform environmental and health insights (Chinnaswamy, 2019). Knowledge is configured through visualization algorithms, supporting policy-making and urban management (Eberhard, 2023).

Integrating decision-making tools to manage resources is especially relevant in complex and uncertain environments (Wu and Shang, 2020).

Visualization and digital tools (are shared across agencies for agile decision-making (Salyakhova and Panfilov, 2023). Power BI, Tableau, QlikView, Python, R, and other tools are used to create these data visualizations and present the data in the form of dashboards, graphs, and so forth (Weissgerber et al., 2024). Budgeting Planning and Forecasting, Profitability analysis, Cash flow planning, Production Cost Planning and Control, and other management activities can all be visualized.

Resources can be managed through interactive maps and dashboards, and models are stored to provide ongoing asset management and planning decision support. CRBT enables firms to make better decisions by leveraging knowledge visualization for strategic planning and operational improvements (Bumblauskas, Nold, Bumblauskas, and Igou, 2017; Canonico et al. 2022).

Furthermore, the visualization of data, information, and knowledge facilitates the communication of financial knowledge and its verification. In addition, visualization tools are used to convey the processes of the financial system. Over the past few decades complexity and the volume of data have increased, resulting in cognitive overload (Bhavnani et al., 2019; Daradkeh, 2017; Goodman, Borkin, and Robitaille, 2018; Tarafdar, Beath, and Ross, 2017; Patterson, Blaha, Grinstein, Liggett, Kaveney, Sheldon, Havig, and Moore, 2014), requiring tools to make sense of this data for strategic and operational decision-making. Data displays such as matrices and networks are often utilized to enhance data analysis (Verdinelli and Scagnoli, 2013) and to understand complex concepts. Visualization enables people to sense-make complex data by aiding visual working memory (Tintarev and Masthoff, 2016) and assisting with numeracy interpretation (Honda et al., 2015).

Task complexity can be reduced by, for instance, using heat maps (Eberhard, 2023; Ferraris et al., 2019; Mikalef, 2021; Ji-fan et al., 2017; Teece, Pisano, and Shuen, 1997) to make decision-making more intuitive. Visual displays help present inferences and conclusions and represent ways of organizing, summarizing, simplifying, or transforming data (Alhadad, 2018). Translational insights were accelerated through visualization in a clinical study by Bhavnani, Visweswaran, Divekar, and Brasier (2019). Visualization simplifies the task attributes, enabling decision-making (Padilla et al., 2018). When SMEs visualize data patterns, uncertainty is translated into reliable conclusions, resulting in effective management decision-making and action, as illustrated in Figure 13, where colour indicates high variances.

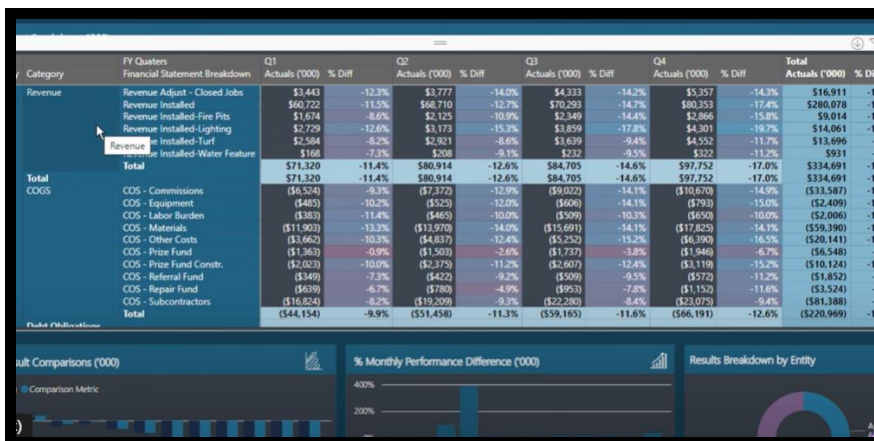


Figure 13: Heatmap Visualization (Open AI, 2024).

Multiple data points can often be too complex and overwhelming, missing key patterns. In the case of two or three data points, heatmaps can present complex data visually and intuitively, allowing users from different disciplines to grasp patterns and trends that would otherwise be lost in vast amounts of data (Daradkeh, 2017). The heatmap enables synchronous communication collaboration between people from different backgrounds, reducing cognitive load through simplification (Allen et al., 2014; Bresciani and Eppler, 2009).

Eberhard found that visualization and heatmaps increase decision confidence (2021). In the workflow process researched, the planning system is also interactive, so users can explore the data by drilling into it by clicking on a field that explodes the underlying data to discern more details about, for example, a practice area. For instance, visualizing profit or loss as a heat map is a powerful way of determining whether system configuration and assumption rules are moving closer or further away from predicting future earnings, as verified against previous years' results (the variance between the actual and budgeted columns reflects the accuracy). BDA has emerged as a field that can assist the legal industry in its data insights.

Global data insights refer to analyzing and interpreting data from multiple sources to derive meaningful patterns, trends, and actionable information to inform decision-making. Global data insights encompass advanced analytics, machine learning, and big data technologies to process vast amounts of data and uncover significant global trends (Zhang, Shang, Cheng, and Hu, 2022). Figure 14 depicts an interactive heatmap that allows one to drill down into the detailed transactions that comprise that summary cell, with the colours assisting in interpreting the data.



Figure 14: Example of Actual vs. Budgeted Profit and Loss Variance Heat Map (OpenAI, 2024).

Visualization provides a common language for communication in a multidisciplinary team (Siemers, 2016), and visualization offers interdisciplinary communication between data scientists and decision-makers, facilitating strategic management decisions (Chiang et al., 2018; Shabbir and Gardezi, 2020). To achieve this, data analytics visualizations can enable an iterative process-based, systematic approach to sensemaking in legal technology (Chae et al., 2014). In the workflow process studied a heatmap could illustrate the liability limits and termination clauses, which could be compared to standard templates, enabling the variance to be described.

By analyzing the use of various workflow processes, together with the IT department, management can detect bottlenecks or dormant activity awaiting authorizations, as illustrated in Figure 15, that could be processed in parallel to avoid additional time (Van Der Aalst, 2016).

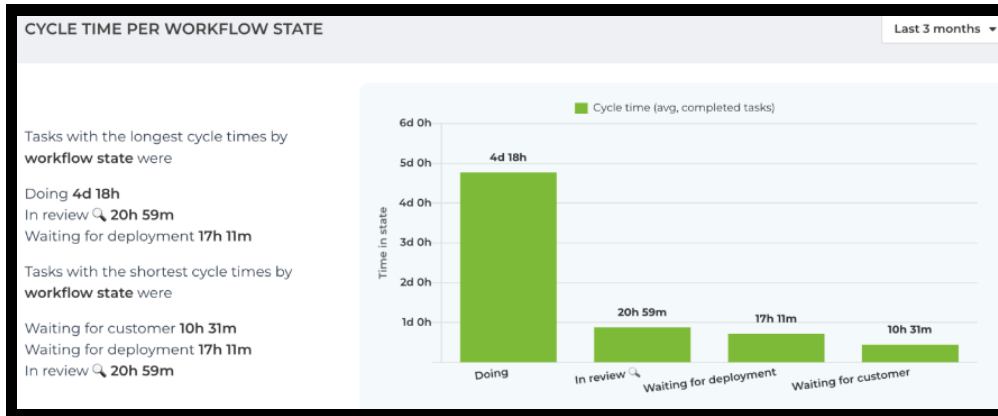


Figure 15: Cycle Time Per Workflow State (Open AI, 2024).

Visualized automated workflows can facilitate KS and learning with others in the firm, improving performance, data security, accuracy, and reliability and addressing inefficiencies in current processes (Balfe, Sharples, and Wilson, 2015; DeCanio, 2016; De Haan, 1999; Nikulina, 2020). In the workflow process studied, visualization confirms the process, transferring the knowledge and allowing the SMEs and SEs to work from a common understanding. Figure 16 below illustrates a very standard planning process with the flow of tasks being visually illustrated:

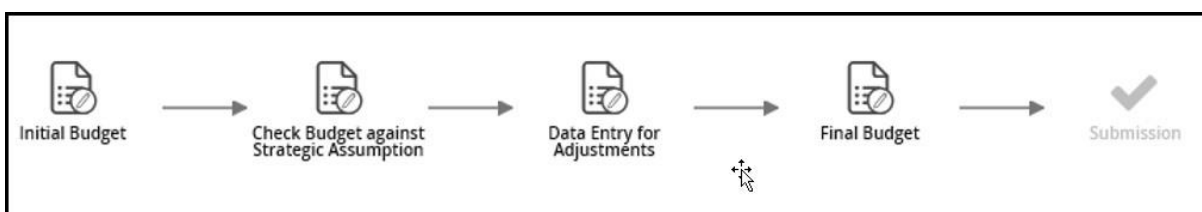


Figure 16: Standard Planning Process Workflow.

The Unified Theory of Acceptance and Use of Technology (Williams, Rana and Diwivedi) can be applied to visualizations in the KS process as performance expectancy must be communicated through visuals, for example, the process flow visuals, which are shared with SMEs and SEs initially to set project timelines and configuration workflows. Effort expectancy can be expressed in, for instance visuals related to the priority

and types of implementation errors. Social influence can be applied during the best practice phase, where SMEs and SEs in various areas and regions advocate for their practices with visualizations of the resultant heat maps with minimal variance between budgeted and forecast actuals in profit and loss reports. Finally, facilitating conditions can be established through adequate support and resources, creating visualizations that enable decision-making.

Visualizations enhance organizational sensemaking by making the shared knowledge more accessible, engaging, and actional, aligning everyone's understanding, especially during the establishment of best practices and transformation of data (Brown et al., 2015). Boundary objects are essential for KS as they allow for a shared understanding between groups, teams, or regions and include reports, prototypes, or models. Visual tools like graphs, dashboards, and flowcharts simplify complex data, bridging gaps between diverse groups. They clarify complex areas, such as understanding assumptions in budgeting through heat maps and visual process flows (Carlile, 2002).

4.9 Enhanced Process Model.

The visualization literature (Bedford and Malmi, 2015; Bhavnani, Visweswaran, Divekar, and Brasier, 2019; Coombs et al., 2020; Eberhard, 2023; Han, Kamber, and Pei, 2012; Kang, Stasko, and Jacko, Krehbiel et al., 2001; 2007; Huutoniemi et al., 2009; Lurie and Mason (2007); Munoz, 2017; Padilla et al., 2018; Shabbir and Gardezi, 2020; Yi, Sackett et al., 2006) covered in the previous section is incorporated into the new model that now includes visualization being used for verification.

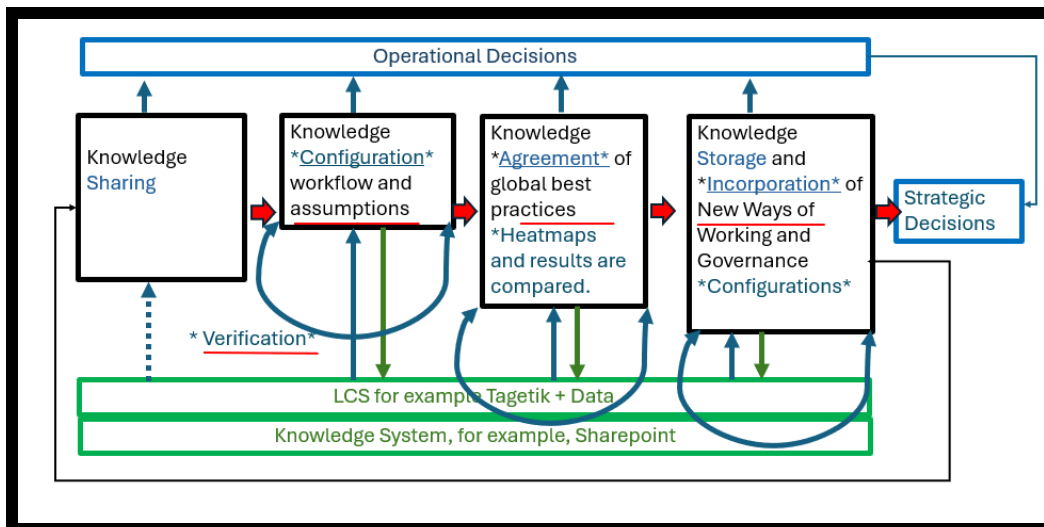


Figure 17: Process of Leveraging Visualizations with Systems for Operational and Strategic Decision-Making

As depicted in blue in Figure 17, visualization assists in sharing, configuring, agreeing, and incorporating new knowledge, resulting in operational and strategic decision-making.

The LCS system with the associated data, as well as the knowledge system or repository (all indicated in green), supports sharing, configuring, transforming, and storing knowledge. Visualization also assists in verifying the configuration and best practice agreement, as well as the final incorporation of those configurations in the knowledge base through the heat maps, which confirm that the configurations result in accurate forecasts that underpin strategic decision-making. Furthermore, the visualization of data, information, and knowledge facilitates the communication of financial knowledge and its verification. In addition, visualization tools are used to convey the processes of the financial system.

Given this enhanced process model, the qualitative study explores how SEs and SMEs use visualization tools and techniques to develop an LCS, how

this knowledge is incorporated into the knowledge system, and how visualization supports operational and strategic decision-making.

The research propositions for the qualitative study are therefore:

1. How does visualization aid in sharing expert knowledge.
2. How does visualization aid in knowledge configuration.
3. How does visualization aid in transforming knowledge to agree best practice.
4. How does visualization aid in the storage of knowledge.

The various stages of the KS process as well as the three visualization roles are depicted in Table 4.

Table 4: Visualization Research Propositions

Visualizations Role In:	Knowledge-Sharing	Knowledge Configuration	Knowledge Transformation	Knowledge Storage
Communication	✓	✓	✓	✓
Process	✓	✓	✓	✓
Verification	✓	✓	✓	✓

This research henceforth focuses on visualization’s role in decision-making and KS. Visualization enables the generation and sharing of SMEs and SEs domain and assumption knowledge, ingesting and making the experts’ tacit assumption knowledge explicit and embedding it in the firm as codified and explicit knowledge; transforming and agreeing of this knowledge into best practice; and finally, the storage and adoption of this knowledge into knowledge bases, policies, and governance.

4.10 Summary

The first phase of the research established that Niche systems focusing on process visualization were key to increasing revenue. As a result, LCS and

LCPs were explored more deeply in the literature. This chapter discussed people as a resource and the KS and conversion process, highlighting the role of visualization. A process model for combining big data with technology and people [who share knowledge] and using visualization to create actionable knowledge was ultimately developed around systems to enable strategic and operational decision-making as secondary enablers of profitability and competitiveness. The role of visualization, enabling the process, verifying the output, and communicating between all the disparate interdisciplinary role-playing siloes was established. Visualizations play a role in communication and verification through complexity reduction. Having established the area of investigation, the literature was explored. Visualization and decision-making, specific to the legal industry, are expanded, and a process model is developed. The next chapter examines the qualitative findings relating the process model developed to what occurs in practice.

CHAPTER 5 QUALITATIVE STUDY SECOND PHASE

5.1 Introduction

This phase of the research sought to establish how law firms make decisions by combining data, technology, and people as a bundle of resources and capabilities to enable decision-making. The process of validating tacit assumptions, converted into explicit assumptions ultimately transferred to knowledge and underpinning decision-making, is explored through qualitative interviews. Having established the role of visualization as a capability in the literature study, the research sought to demonstrate how visualization aids in KS, configuration, agreement of best practices, and storage. This process is a generic workflow process of planning systems implementation called the KS process.

This research phase is based on a case study involving KS between System Experts SEs and SMEs at a departmental and global level, contracted by these firms to develop and maintain a financial system. SMEs and SEs in legal strategic and operational decision-making systems were interviewed to determine whether what the SMEs do in practice matches the proposed knowledge process model based on the literature and the experience of the researcher. The research phase focuses on SEs and SMEs involved in implementing decision-making systems in large multinational firms to improve planning. KS, knowledge configuration, including how assumptions are coded and turned into explicit algorithms, was a focus. The transformation of these explicit rules and agreement on regional best practices was also researched. Finally, how these processes were internalized, and the knowledge shared with other SMEs and SEs through a knowledge base was explored.

This research phase sought to establish whether the process developed from the literature was replicated in financial transformation

implementation projects in practice. The research phase analyses how:

1. Visualization aids in sharing expert knowledge.
2. Visualization aids in knowledge configuration.
3. Visualization aids in transforming knowledge to agree best practice.
4. Visualization aids in the storage of knowledge.

5.2 The Knowledge Process

5.2.1 SMEs and SEs Sharing Knowledge

For this phase of the research the research question was how the proposed model replicates strategic and operational decision-making in practice. Respondents were asked how they convey and adapt what they base their SME decisions on to other SMEs within their region. The SMEs and SEs were asked to elaborate on using visualizations to communicate their expert planning, budgeting domain, and implementation knowledge when conveying communication, workflow understanding, and verifying information.

Regarding visual communication priorities, the respondents emphasize simplicity, purpose-driven visualizations, gradual complexity, and audience focus, ensuring clear communication and stakeholder understanding. The respondents use slides, workflow diagrams, and decision trees to convey complex workflows to clients; it relies more on text and verbal communication for internal developers. The respondents recognize the need for standardized visual cues and consistent communication methods, mainly using simple, standard visualizations and tools like Excel and PowerPoint. Using the traffic light system effectively manages information overload and drives meaningful conversations.

The respondent notes that their developers gravitate towards consistent styles and themes across the team when presenting their data insights. This suggests that individuals internalize effective visualization techniques over time and share standards of what entails a good visualization, enhancing SME collaboration and process improvement. Visualization enhanced KS through the tacit-to-tacit sharing phase of implementation when users share their domain knowledge by leading by example. This process phase aligns with the first phase, which developed from the literature regarding generating and sharing knowledge.

Concerning KS, the SMEs emphasized conveying their understanding of billing cycles, cash collection, forecasting, and planning and conveying this to other stakeholders through visualizations, such as highlighting process flow bottlenecks in workflow authorizations. They specifically underlined the importance of reducing the number of days from Work in Progress (WIP) to billing to expedite cash collection as being a key objective they focused on, and the success of this was often confirmed through visualizations showing the prior and current WIP lock-up as a measure of success. This verified the process, billing, cash-collection patterns, and forecasting assumptions.

Regarding process standardization, one SME said, “Some of these tiles are colour-coded to represent various things. However, there isn't much standardization in our day-to-day process.” He explained that he often creates visual aids to communicate the meaning behind icons and colours as indicated in Figure 20 for example, where the green icon with an upward arrow indicates an upload. A respondent mentioned, “I use the system to articulate the points of interest within that process and a workflow to say this is where the process is going.” Figure 18 depicts an example of such a process.

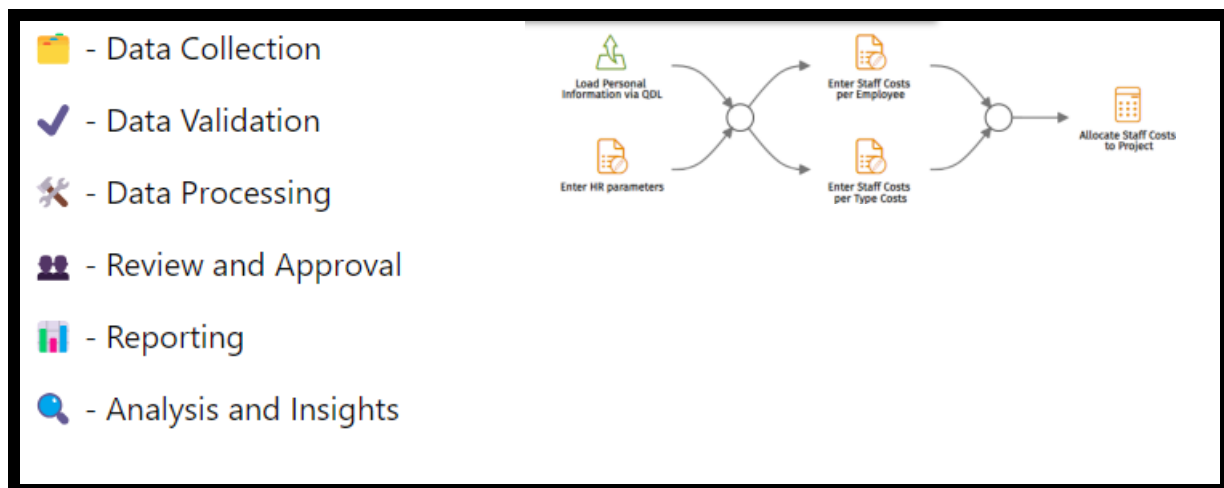


Figure 18: Icons and an example workflow (OpenAI, 2024).

The SMEs and SEs use a combination of technical language, verbiage, and application screenshots within a presentation to convey implementation knowledge. They also use videos and swim lanes (lanes indicating what a specific role-player does) to represent the process flow and areas of responsibility visually. The respondent highlighted the importance of effectively conveying expertise among SMEs and the value of data in improving processes.

Regarding verification and the highlighting of implementation data errors, an SE said, "Visualization tools, such as data mapping and error statistics, are vital for identifying issues and areas for refinement in the data conversion process." The SE conveyed the state of the implementation through a spreadsheet outlining the number and types of errors, thereby visually conveying the error status compared to other areas and the severity of these errors (comparatively). Table 5 below illustrates how SMEs and SEs use visualizations for KS and tacitly lead by example. Heat maps are used to identify areas for improvement, and utilizing KPIs was emphasized.

Table 5: Responses to Knowledge-Sharing Questions

Phase	Themes	Detail	Communication	Process	Verification
KS	Conveying process	Uses flowcharts, waterfalls, dashboards, and swim lanes to represent process flow and areas of responsibility visually	✓	✓	✓
	Conveying conversion trends	Data mapping and logging help identify issues and areas for refinement. Maps of data conversion assist in the verification.	✓	✓	✓

5.2.2 SMEs and SEs Configuring Knowledge

SMEs and SEs were asked whether visualization explicitly aids in making rules relating to processes and assumptions. Visualization enables embedding knowledge in the firm as codified and explicit knowledge.

Respondents were asked what kinds of information they provided to the system experts to code the workflow and assumptions. They were asked to elaborate on what systems they use to help in communication and configuration. The SE explained that “they provide SEs with standard symbols and colours for workflow diagrams to ensure consistency across all processes, regardless of the task.” Another SME mentioned, "Visualization can help people understand complex systems and data flows more effectively than text.” Another respondent said, "Visualization is critical for conveying complex information, ensuring consistency, facilitating feedback, and effective project communication.”

SMEs and SEs in planning shared their underlying assumptions to enable the configuration of the rules to be programmed to automate the system. A respondent stated, “Visual aids are crucial for training SMEs to understand the new processes and system's configuration”. This phase involves converting tacit budgeting assumptions into explicit algorithmic form.

Respondents mentioned using workflow diagrams to show the steps of their standard workflows and document their processes. They also organize a walkthrough of the client's process document to align it with theirs. The output of this process is a business design document that determines how the workflow will work for that client. They also use visualizations to help clients understand their data migration process”.

A respondent mentioned he relies heavily on visual aids to communicate with regional SMEs and other stakeholders. These are included in algorithms that calculate the budgets based on billing patterns and collection seasonality assumptions. Analysis, synthesis, and observation compare these budgets to actuals through various visual representations, including profit and loss variance, in a heatmap format. This process is performed for data from a few previous years, progressively refining the assumptions and producing more accurate budgets with less variance. One of the respondents said he acknowledges that the value of visualization for verification might be less than for communication and process, although it nevertheless plays a role.

SMEs and SEs are required to pre-populate the budget through verified prepared data loads and system setup data. General revenue planning, employee assumptions, and capital and project assumptions were enabled using common symbols to create a shared understanding of the process and its outcomes. Using symbols in workflow also assists users in compliance. These assumptions were structured in a workflow process configured by the expert to ensure the user performed the functions in the correct order so that mistakes related to users changing underlying assumptions later in the process are avoided. The visualized workflow process eliminated errors in previous years, where the underlying assumption was changed (for

example, the number of business days) without rerunning all the subsequent calculations that used this base data. Scenario planning and sensitivity analysis are underpinned by an understanding of current processes and predictions and are enabled by saving different budget versions driven by different assumptions or dimensions. This honed the accuracy of budgets, as the best options can be communicated to others and further developed or progressed.

The knowledge accumulated through years of experience in the industry (for example, through exposure to trends, regulatory changes, and benchmarking), intuition, and understanding of the practice areas were made explicit. Budget variances are traditionally caused by incorrect assumptions, process problems (e.g., not recalculating once underlying assumptions change), inaccurate data starting points, and calculation errors. In addition, changing business conditions, market, political, and regulatory changes, and even the number of days worked during the COVID-19 pandemic caused variances. In budgeting, the experts worked towards “reducing the red,” which can be translated as reducing the budget estimation errors or variance. The areas that had higher variance generally needed to be underpinned by more defined assumptions. Assumptions include information related to Billable Hours and Billing Seasonality, Collection Seasonality, Productivity, Rates, and Realization, and informed Revenue Planning. “Visualization helps in understanding workflows through tools like waterfalls and dashboards.” The respondent explained that he provided details about the business drivers, key milestones, and the reasons behind certain decisions to the SEs to code the workflow and assumptions. “I use visualizations to verify the information's accuracy and identify areas needing attention.” A different SE noted, “Visual tools like waterfalls and heat maps track variances and inform budgeting and forecasting cycles.” Visualization effectively communicates and verifies, allowing for self-service understanding and identifying issues or successes immediately.

About documenting or translating explicit knowledge that could be shared for the collective benefit in the form of algorithms and documented workflows, one of the respondents noted that this is not being done as extensively as it should be, “Despite the extensive use of visual aids, there is a lack of standardized notations for daily processes, making these tools essential for communication.” The following common themes emerged, as depicted in table 6:

Table 6: Responses to Knowledge Configuration Questions

Phase	Themes	Detail	Communication	Process	Verification
Knowledge Configuration	Conveying assumption trends.	Visual tools like waterfalls and heat maps track variances and inform budgeting and forecasting cycles.	✓	✓	✓
	Conveying process.	Uses flowcharts, waterfalls, dashboards, and swim lanes to represent process flow and areas of responsibility visually		✓	
	Conveying project trends.	Dashboards: Interactive tools for dynamic communication; Power BI: For data visualization and representation; Excel Sheets: Validation sheets with colour-coding to show data discrepancies.	✓	✓	✓
	Conveying conversion trends	Data mapping and logging help identify issues and areas for refinement. Maps of data conversion assist in the verification.	✓		✓

Visualizations are crucial in conveying complex workflows and ensuring that all stakeholders are aligned, though they are often developed as the project progresses to ensure accuracy and address discrepancies. These themes highlight the importance of visualization in effectively communicating

detailed workflows, verifying data accuracy, KS with SMEs, and ensuring consistency and clarity in communicating complex processes and decisions.

Respondents mentioned that while they don't use visualizations to convey workflow understanding, they use visualizations to highlight processes' bottlenecks. For example, they might create reports that show if a particular step in a process consistently takes longer than expected. This highlights the role of visualization in making rules explicit and standardizing process steps.

The respondents felt that “for some audiences, like lawyers, the respondent visualizations must be straightforward, almost like a simple gauge indicating good or bad.” The respondent believes that gradually introducing visualizations can be compelling. Users who become comfortable with basic visualizations often request more complex ones. Initially, the admin team drives the process and guides the client. The process is reversed as they reach the final stages, with clients providing feedback to the admin team. This allows the admin team to identify gaps or issues in the configuration setup.

5.2.3 SMEs and SEs Agreeing Global Best Practice

SMEs and SEs were asked whether visualization aids agreement regarding best practices. Budget accuracy is improved during the phase in which best practice standards are agreed upon. A respondent referring to regional variations said, “Some calculations are regionally driven, while others are more global.” The respondent mentioned that in his current program, which spans multiple regions, each region might calculate specific metrics (like lock-up days) differently.

Regarding solidifying assumptions and improving accuracy, respondents were asked how other SMEs agreed upon the information they provided to configure the system and drive the calculations. They were asked to elaborate on any forums or workshops to facilitate this. SMEs and SEs mention using forums and seminars to facilitate the agreement process. These forums and workshops are used to discuss the overall process with clients, to understand their process, and to align it with the system's process. Visualizations are also used to agree on this knowledge. The SMEs mention that visualizations, such as workflows and process summaries, represent the business process and ensure a common understanding among SMEs and developers.

Domain experts shared their explicit beliefs between firm offices and regions. Once approved, SMEs shared that assumptions are aggregated, consolidated, and ready for final sign-off at a regional and group level. This cross-pollination ensured more accurate budgeting. A respondent explained that some regions opted to show the entire workflow process to provide context and have a “no-entry” sign over those processes irrelevant to a particular user. An SE explained that they always hold a workshop to review and document the regional variations of the process before configuring the system and driving the calculations. Several task flows could reflect the different entities’ or regions' calculation model requirements. Common themes emerging were the following, as depicted in Table 7 below:

Table 7: Responses to the Agreement of Best Practice Question

Phase	Trends	Detail	Communication	Process	Verification
Knowledge Transformation	Buy-in, Agree Best Practice	SMEs agree on system configuration and calculations, with decisions typically suggested by application consultants and agreed upon by business owners. Align requirements achieving cultural buy-in and standardization.	✓	✓	✓

		Uses flowcharts, waterfalls, dashboards, and swim lanes to represent process flow and areas of responsibility visually	✓	✓	
	Highlight differences (between regions/offices).	Dashboards: Interactive tools for dynamic communication; Power BI: For data visualization and representation; Excel Sheets: Validation sheets with colour-coding to show data discrepancies.	✓	✓	✓

When agreeing best practices, understanding the drivers of results in real-time and having volumes of data easily translated into actionable insights and value creation resulted in expedited decision-making facilitated by visualization. Time-series analysis involves the analysis of historical data to identify patterns and factors affecting the outcome, such as policies, economic growth, and client preference, to be used in assumptions and forecast planning.

Participants use a mix of workshops, forums, and visual tools to ensure SMEs agree on the information required for system configuration and calculations. Visualizations are crucial in facilitating understanding, ensuring consistency, and validating processes, although they are often developed later in the project to address specific needs and discrepancies. There is potential for increased use of visualizations to enhance the agreement process and overall effectiveness and ensure transformation buy-in.

These themes highlight the role of visualization in facilitating understanding, ensuring consistency, and driving process step buy-in through workshops. They also emphasize the need for earlier integration of visual tools, for example, to agree on the workflows earlier in the project and

the focus on simplicity and business context for effective system configuration and implementation.

5.2.4 SMEs and SEs Storing Knowledge

Respondents were asked how they, as individuals, make the new knowledge their own, store this, and apply it within the next budgeting and forecasting cycle. When elaborating on the Knowledge Transition phase, a respondent said, “The focus is more on enabling the client firm to create their visualizations in the future rather than refining the team's knowledge base.”

These themes emphasize the standardization challenges and the potential for leveraging advanced technologies like AI for data analysis.

About a knowledge base to assimilate and adopt visualizations from one implementation for future implementations, an SE said, “This library includes visuals with icons and other presentation materials. When needed, I use these visuals to facilitate the implementation process in the next budgeting and forecasting cycle”. An SME said, “I use visualizations to track budgets and actuals and to identify variances.” The SMEs worked with the process analysts and the system configuration experts to ensure the underlying assumptions were calculated accurately. Table 8 reflects the responses to the knowledge storage questions.

Table 8: Responses to Knowledge Storage Question

Phase	Trends	Detail	Communication	Process	Verification
Knowledge Storage	Governance	Visual summaries and customized library with icons and presentation materials to facilitate future implementations.	✓	✓	✓

	Conveying best practice	Internal reviews to document lessons learned, using visual summaries to confirm and adjust processes for the next cycle, are being conducted.	✓	✓	✓
	Conveying best practice.	Dashboards: Interactive tools for dynamic communication; Power BI: For data visualization and representation;	✓	✓	✓

Table 6 above depicts the themes that arose during the knowledge assimilation phase. Individuals use various feedback and visualization tools to make new knowledge their own and apply it in subsequent budgeting and forecasting cycles. Visual cues and tools are integral in communicating and understanding. Through iterative cycles, visualizations assist in improving the accuracy of the assumptions and refining future scenarios, enabling better strategic direction. The respondents indicated that structured visual tools support effective system configuration, process understanding, and continuous improvement in business practices. Another respondent said, "We have changed how we run our governance meetings to focus on critical areas using visualizations, making the governance calls more focused and efficient."

The focus is on transitioning knowledge to clients so they can create their visualizations in the future. One respondent mentioned that "their team maintains a consistent style and theme across developers." This corresponds to the phase that became evident through combining the knowledge process literature regarding knowledge assimilation.

5.3 Main Findings

The main findings were as follows:

5.3.1 Communication

Structured meetings, reviews, and workshops are essential for clear communication and alignment among SMEs and SEs. Visualized documentation, demonstrative media, and standardized notations help maintain clarity and consistency throughout the project lifecycle.

SMEs and SEs felt that visualizations should be kept as simple as possible to ensure stakeholders can easily understand them. The focus should be on why something should be visualized rather than just putting information on the screen. Visualizations should be audience-centric and tailored to different stakeholder needs and levels within the business.

SEs prefer using standard, simple visualizations like stack bar charts rather than creating custom, complex visualizations. Heat maps display 2-3 data points, allowing drill-down capabilities to prevent complexity overload and help verify data, spot outliers or issues, and help identify process bottlenecks. Various visualization tools, including PowerPoint, Microsoft Visio, dashboards, Power BI, and Excel validation sheets, are used extensively during implementation. These tools aid in highlighting critical information, verifying data accuracy, and facilitating process understanding.

Respondents start with very simplistic visualizations and then "breadcrumb" into more detail if the user requires more detail. These were then reviewed by the budget owners and strategic management, different from the SMEs developing the budget and representing a range of disciplines. SMEs confirmed the results through visual heatmaps and other graphs and charts. They find heat maps particularly effective because they usually look at 2 or 3 data points, avoiding information overload. By visualizing the assumptions (for example, comparing the budgeted versus actual results

through a profit and loss report heatmap), the red areas, indicating higher variances, were removed in iterations. A respondent mentioned using a mind map to identify possibilities within a process flow. Additionally, she talked about using a heat map to highlight unexpected values. Visualization assists with complex task attributes, facilitates decision-making, and enhances profitability (Ferraris et al., 2019; Mikalef, 2021; Ji-fan et al., 2017; Teece, Pisano, and Shuen, 1997). The constraint regarding their effectiveness in terms of the data points represented must be noted. The SEs noted that heatmaps become less effective for highlighting insights beyond three data points as the visual becomes too noisy and inhibits stakeholder comprehension.

5.3.2 Process

Visualizations are used to convey process understanding and to lock users into following the correct process. When discussing Decision Trees, a respondent said, "The billing workflow includes a picture showing decision points. It has a flow-through with decision trees to explain why specific actions are triggered. For example, it might show, "Does it need approval? Yes or no" or "Was the write-off more than a certain percentage? Yes - it's going to kick off this workflow."

5.3.3 Verification

At specific points in this cycle, the project team generates insights that produce actional decisions like, for example, opening a new office or closing a non-profitable practice area. These actionable decisions add to our dynamic, flexible capacity bundle by supporting decision-making and reducing complexity. Wu, Lin, Gupta, and Kar (2024) found a positive

correlation between these capabilities and firm performance, with dynamic capability potentially mediating this relationship.

Visualizations are used to verify results. For example, the heat map of the comparison of actuals to forecast verifies whether the current assumptions are generating more accurate forecasts. The respondents admit they could better use visualization when communicating with developers or system experts to code workflows and assumptions.

5.4 Summary

The SMEs initially used visualization to share their tacit-to-tacit knowledge creation. After this visualization aided in configuring systems and agreeing process, enabling tacit to explicit assumption creation; visualizations often depicting assumptions were leveraged during the best practice agreement phase; and finally, the visualizations relating to assumptions and other knowledge were adopted and assimilated. Respondents used visualization to share expertise, convey and arrive at explicit assumptions, agree on best practices, and embed knowledge. A respondent mentioned, “Visual tools explain complex processes, like billing workflows, and ensure consistent understanding among regional SMEs.”

These themes emphasize the critical role of visualization and structured processes in enhancing the capabilities of legal firms through the implementation of LCS together with visualization. They highlight the importance of balancing execution and vision, leveraging automation, and maintaining effective communication for improved decision-making and competitiveness.

The chapter covered the research findings, outlining the process of leveraging LC systems with visualization. Variance heat map visualizations and symbol workflows enhanced budgeting accuracy and made budget assumptions explicit, demonstrating the potential of visualization to contribute to financial performance. Similarly, Nikulina (2020) found that firms with explicit budget assumptions had better investment returns. Interdisciplinary communication and types of visualizations are expounded on. The common themes are summarized, and the chapter concludes with a summary.

CHAPTER 6 QUALITATIVE STUDY DISCUSSION

6.1 Introduction

RBT is an essential theory in business and management practice because it focuses on the bundles of resources owned by a firm and how they differ (Helfat et al., 2003; Peteraf and Barney, 2003). The internal firm of resources is critical to understanding success or failure within the firm (Kozlenkova et al., 2014). The firm possesses unique resources in specific situations and can be more skilled in performing activities and creating capabilities, differentiating itself from other firms. Resource immobility is reflected in the complexities of trading resources across firms. The traditional RBT must elaborate on why and how some firms gain a competitive advantage in unpredictable and rapid change (Ron and Helfat, 2003). The RBT emphasizes the importance of a firm's internal resources (financial, human, information and technology, management) for establishing core competence and providing a competitive advantage.

The ability of a firm to collect, prepare, and analyze its data differentiates it from others (Ferraris et al., 2019). A new concept of dynamic capabilities was introduced by Teece, Pisano, and Shuen (1997), creating, extending, upgrading, protecting, and keeping a company's asset base relevant to a changing environment (Acedo, Barroso and Galan, 2006). This extension can be achieved through big data deployment, as Seddon and Currie (2014) found, in high-frequency trading analysis in financial markets. Wright, Robin, Stone, and Aravopoulou (2019), studying firms innovating to stay ahead in the market and expand activity, discovered that using big data creates new offerings and product development capabilities. Strategists are, therefore, discovering that big data exploration and management should be designed to leverage discovery and analysis (Davenport,

2014). Organizational processes must be defined and applied to exploit resources (Peteraf and Barney, 2003). Data is one of these resources.

Intelligent automation enables efficient work processes (DeCanio, 2016), analysis, decision-making, and action implementation (Balfe, Sharples, and Wilson, 2015). Knowledge is built on extracting value from a large variety of data and information sources (Becerra-Fernandez and Sabherwal, 2014) to make management decisions, and machine learning can be used to streamline firm processes (Neirotti and Paolucci, 2007; Rivard, Raymond, and Verreault, 2006; Tarafdar, Beath, and Ross, 2017).

Accelerated digital transformation through citizen developers improving internal processes and increased responsiveness to business are the main reasons for implementation cited in a 'State of Application Development Report' (OutSystems, 2019). LCS provides a simplified interface, allowing functional super users with varying technical expertise to create applications, rules, and visualizations. This enables members from different disciplines to collaborate in the development process, breaking down communication barriers and sensemaking of complex data (Alhadad, 2018; Bhavnani, Visweswaran, Divekar, and Brasier, 2019). It is also easier to identify outliers with a graphical interface (Akoglu, Tong, and Koutra, 2014).

Research on the application of SECI to visualization techniques in KM is limited. Eberhard (2023) found that information visualization improves decision quality and speed with mixed effects on decision confidence. User and task characteristics and cognitive aspects all influence the process. Significantly, few studies are related to

visualizing budgeting assumptions and using these to facilitate improved accuracy (Siemers, 2016).

Data visualization plays an essential role in research by enabling the direct display of complex information and assisting researchers in identifying implicit patterns. Despite its importance, the use of LLMs for data visualization remains relatively unexplored (Yang, Zhou, Wang, Cong and Han 2024). Research on using Natural Language (NL) to generate visualizations has emerged. This allows users to create visualizations using Natural Language Interfaces (NLIs), reducing the skills required and improving the usability of these tools, making data insights more accessible (Shen et al., 2023).

6.2 Interpretation of the Findings

6.2.1 Overall Visualization Themes SMEs Vs. SEs

Table 9 Overall Visualization Themes SMEs VS SEs

Theme	Component	SE	SME
Communication	Understanding	✓	✓
	Facilitate Workshops,	✓	✓
	Complex data is more accessible.	✓	✓
Process	Representation	✓	✓
	Improvement of process and governance		✓
	Governance		✓
Verification	Identifying Issues	✓	
	Comparison with Expected Outcomes (outliers)		✓
	Identifying Process bottlenecks		✓

Table 9 shows that visualization is a powerful tool that significantly enhances communication, process understanding, and verification. A tick indicates that at least one SE or SME indicated that visualization enhances the component in question. It makes complex information more accessible, aids in representing and understanding processes, and helps identify issues during verification. While detailed text and spreadsheets are still necessary

for thorough verification, visualization provides a crucial initial overview and facilitates more effective communication and process management.

Visualizations are crucial for effective communication, data verification, and supporting processes. Emphasizing simplicity, standardization, and audience-centric approaches can enhance understanding and enable better decision-making. There is significant potential to improve the use of visualizations in technical communication and project implementation, with evolving client expectations driving the need for more dynamic, accessible, and user-friendly visual tools.

6.2.2 Future of Visualizations

The explicit inclusion of visualization in the KS process model sets the scene for full-scale automation and added AI. Most SEs mentioned interactive reports and that reports will provide visual data alongside AI-generated written or spoken commentary in the future. They believe Heat Maps effectively visualize reports with 2-3 data points, for example, Profit and Loss reporting and budgeting, indicating the overall profitability of a firm and the budgeted variance thereof.

Overall, the future of visualization is seen as increasingly dynamic, interactive, and user-friendly, with significant potential for AI integration and personalized insights. The emphasis will be on making visualizations accessible, understandable, and flexible to meet growing expectations and demands. This research has demonstrated the contribution of visualization to codifying and sharing knowledge. An SE finds AI interpreting numbers and providing commentary on visualizations interesting, becoming more common in the future. A respondent sees potential in refining AI-generated commentary to be

more accurate and tailored for individual firms. While respondents believe these advancements are coming, they're unsure if it will be "a year away or ten years away." There's a growing expectation for visualizations to be available on mobile devices, not just in office settings. Respondents acknowledge that AI is an obvious route for the future of visualizations, though some consider other aspects more important. The respondents emphasize the importance of dynamic information presentation. They mention current work using Power BI to create visualizations allowing different filters and views of the same data set. The respondents suggest that being able to talk to the computer to explain what is wanted, rather than typing it in, could be a future development.

The respondents proposed using AI to manage daily tasks and bills, suggesting that this could improve efficiency and reduce the workload of legal professionals. They also highlighted the importance of regularly reviewing and revisiting forecasting assumptions to ensure accuracy. Overall, the respondents see the future of visualization as moving towards more dynamic, interactive, and user-friendly presentations of data, with a focus on making complex information accessible to all users, potentially aided by AI and voice interaction technologies. The SEs were asked about the proposed planning automation suggestion using the LLM and SMEs.

An LLM is a type of AI system trained on a massive dataset of text and code. LLMs like Bidirectional Encoder presentations from Transformers (BERT), GPT, Flan-T5, LLaMa, Palm, and Bloom use prompts, which are run through a model to provide a completion that can be defined as a continuation or an extension of a given input prompt (Naveed, Humza, Ullah, Qiu, Saqib, Anwar, Usman, Akhtar, Barnes, and Mian, 2024). This is known as General Artificial Intelligence (GAI), aiming to achieve the same flexibility of thought as a

human plus the super-abilities of a digital mind. Their use cases are essay writing, summarization, translation, information retrieval, and invoking Application Programming Interfaces (APIs) and actions (Naveed et al., 2023). They are predicted to be able to self-learn in the future, and forecasting is an avenue that is being targeted as a use case (Makridakis, 2023). A foundational model can apply what it has learned from one area to another. This could lead to a hallucination when the model answers incorrectly. Knowledge graphs, also known as semantic networks, are a way of thinking about knowledge as a network to understand related concepts and the patterns between them.

The respondents felt heat maps were attractive for P&L and budgeting but questioned the lawyer's general comprehension. They believe heat maps simplify understanding budget information by showing what's on or off track. In general, they see value in enhanced understanding through visualizations but stress that these would be more meaningful if the users could interact with them to gain more understanding.

Overall, respondents see significant potential in using visualizations to enhance budgeting and forecasting systems, focusing on AI integration, simplicity, user-centric design, and gradual adoption. The respondent explained that she uses heat maps to identify areas needing improvement and that KPIs can be a powerful tool when understood and agreed upon by the team. They also discussed the importance of change management and training to ensure everyone is on the same page and understands the data. Lastly, the respondent expressed her vision for the future of data visualization, emphasizing its importance as a primary interface for users.

The respondents envision that "reports will talk to you in the future." Users might log into a screen and receive both visual data and AI-

generated commentary, either written or spoken. He believes using a heat map to drive budget understanding (showing what's on track or off track) is a much easier way for people to grasp the information. The respondents haven't seen technology that comes "out of the box" to implement this system quickly. In their experience, they typically use data from the budgeting tool and transform it into more easily consumable information. He sees this kind of visualization more as a reporting layer on top of the budgeting tool rather than an integrated part of the tool itself. The respondents' comments suggest he sees value in using visualizations like heat maps to make budgeting and forecasting information more accessible and understandable. He notes that the legal industry could be more mature in how it uses technology and data, implying there's room for improvement in this area.

Previously, Blackburn, Lurz, Priese, Göb, and Darkow (2015) used a predictive analytics approach to forecast demand in the process industry. Delen and Demirken (2013) found prescriptive analytics vital to supporting evidence-based management and optimized decision-making. Forecasting, assisted by visualization, assists firms by enabling informed decisions about patterns or trends. By amending various dimensions, revenue planning is aided by understanding how this would change over time. Cash flow planning can assist firms in avoiding cash flow challenges through a more in-depth understanding of their collection seasonality. Additionally, by modeling various scenario outcomes and applying them to different regions and practice areas, the deployment of resources can be maximized for the best outcome. Finally, forecast error analysis involves comparing the actual results to the forecasted results in the same manner applied during the budgeting phase to identify patterns such as overestimation or underestimation linked to variables such as economic growth or interest rates.

6.3 Implications of the Study

Visualization is a communication form that simplifies sensemaking and provides a common language for decision-making. It is impossible to configure and automate the configuration of the expert assumptions of budgeting experts without working across barriers and siloes. The results suggest that fragmented ways of working should be re-examined and replaced with communication and collaboration across domains and siloes. Data, LCSs (specifically workflow systems in the study), and people enable configuration through the SECI process. The dynamic capability of knowledge can be automated through visualization. “So, in my day-to-day work, it is an absolute must. I wish I could say 1,000%. Yes, to this, because. I must have a PowerPoint presentation if I am booked for a workshop on any module. I must have visual cues. From my experiences, visualization is crucial for effective communication, especially regarding complex processes or concepts.”

The process model that has been constructed through the review of the literature has several implications for interdisciplinary communication. Visualization unites interdisciplinary research agendas, providing clarity and integration throughout the firm, with the data scientist at the system's heart. It has been noted that the various departments or sections within the firm have slightly different data requirements and visualization preferences. The respondents indicated that they hold structured meetings and reviews to ensure alignment on configuration and communication. “We use visualizations to verify information accuracy and highlight areas needing attention.”

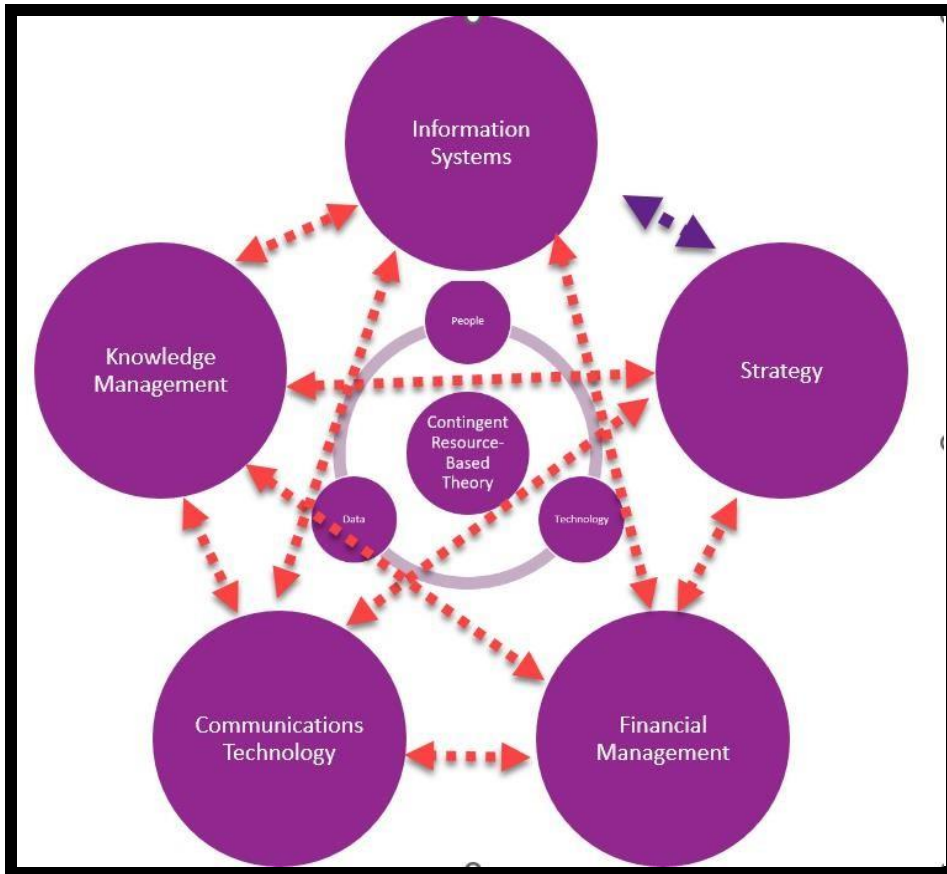


Figure 19: Interdisciplinary Communication Between Teams

Figure 19 illustrates the interdisciplinary communication between the various teams during the Financial Planning Implementations. The LCS examples are Workflow Systems housing the Budgeting and Forecasting Systems that work seamlessly with the Legal Management Systems to facilitate communication. The knowledge process enables the conversion of tacit assumptions into explicit assumptions. These assumptions are documented and shared via SharePoint or similar systems. The LCSs are then also configured with these rules. The communications technology is enabled by Dev Ops or similar technology. The summarised visual communications are required as the volume of information conveyed is too large to document individually. Additionally, management only wants to see what has changed and what is red, indicating a problem—the path to green needs to accompany the visuals in more detailed communication.



Figure 20: Interdisciplinary Communication Between Teams – Visual Trends

Figure 20 illustrates the path of three major projects. For example, the first one is moving from amber to red. Milestones are depicted through commonly agreed symbols and colours. Various projects need to be visualized on the same page. A respondent discussed the importance of breaking down requirements into components (must haves, nice to haves, and middle-of-the-road features) and visualizing these using a chart. “I use a standard traffic light system (green, amber, red) to indicate the status of tasks and drive conversations about issues.”

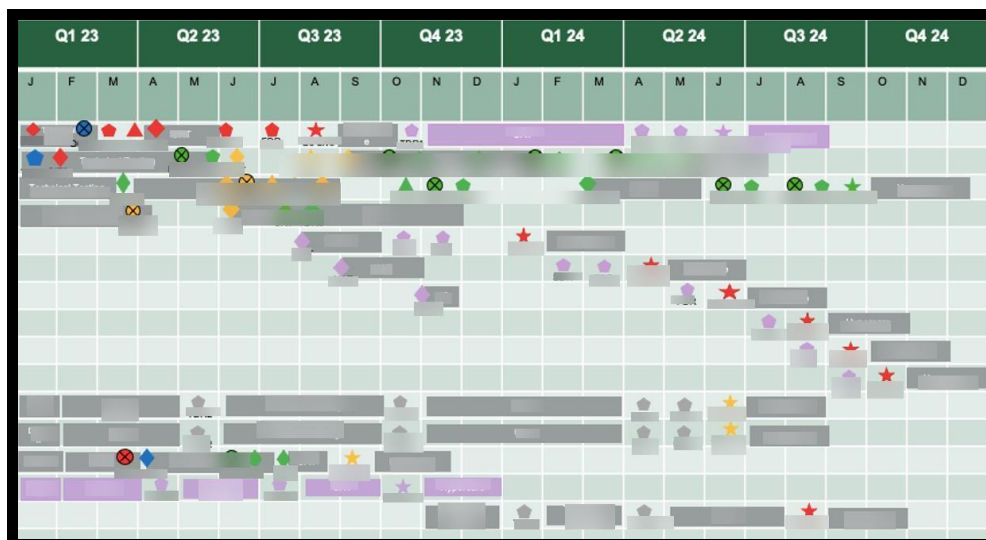


Figure 21: Interdisciplinary Communication Between Teams – Visual Project Plans

Figure 21 depicts a project plan where, for example, go-live is always depicted as a diamond. Statuses are communicated through commonly agreed colour interpretations, and finally, actions to rectify the status to green (on track) or blue (complete) are detailed. Kauppinen-Räisänen and Luomala (2010) also found commonly understood meanings in colour.

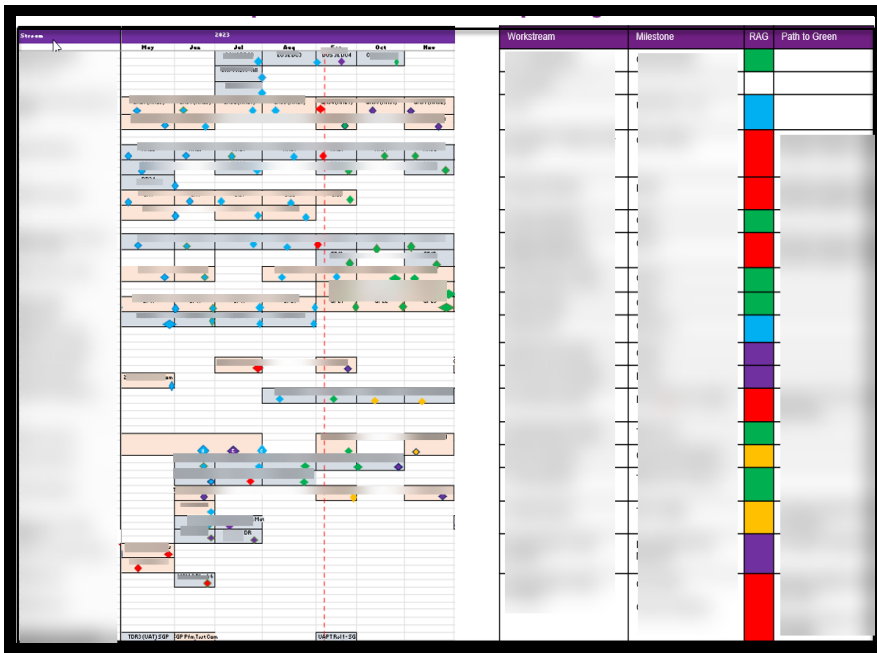


Figure 22: Interdisciplinary Communication Between Teams – Visual Status Report of Various Areas.

Figure 22 illustrates the shared use of colour and symbols on a project. Financial Management, Budgets, and other reports facilitate resource allocation and planning. Heatmaps generally facilitate sensemaking as attention can be paid to red areas due to variances from the expected values. The respondents indicated that they use a visual representation of potential buckets of work. In terms of conveying their subject matter expert decisions, the respondent mentioned that they often work with someone familiar with the budget to feed that information into the process.

The KM process was applied to improve actionable decision-making, highlighting the role of visualization in knowledge creation and sharing phases. The research establishes a KM model by highlighting the role of visualization in improving actionable decisions. Visualization benefits are demonstrated through a qualitative study that explains the challenges of the knowledge process and provides solutions.

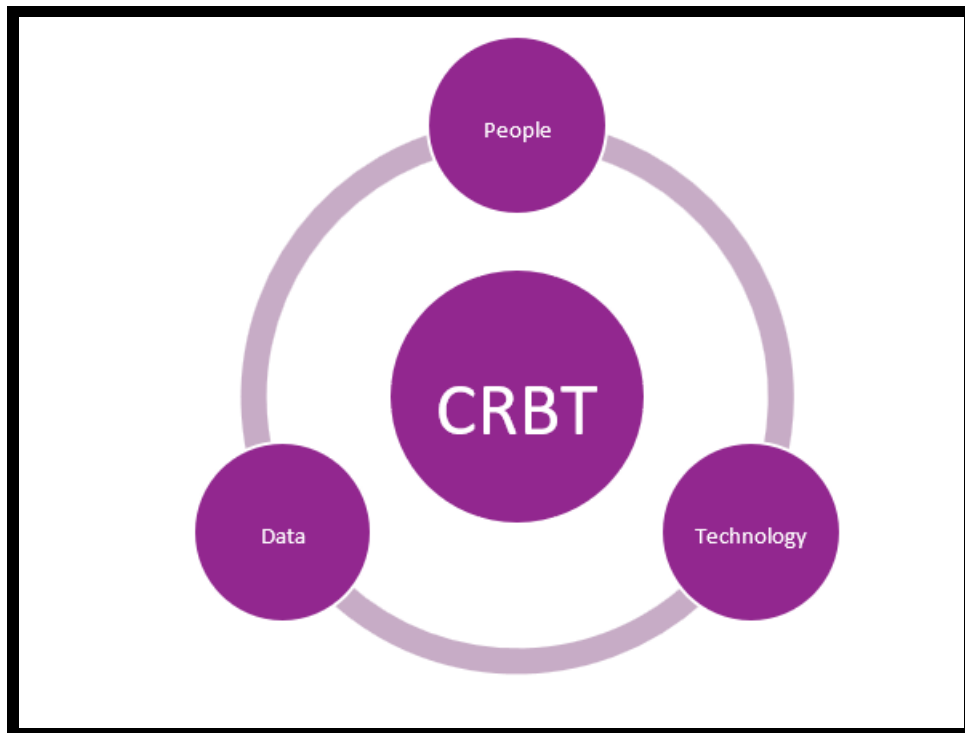


Figure 23: A bundle Of Resources Enabling Dynamic Capability

Figure 23 depicts how people, data, and technology, as a bundle of dynamic capabilities, are driven by CRBT and at the center of interdisciplinary communication. This is enabled by the knowledge process of cycling tacit assumptions into explicit assumptions. This allows a dynamically configured knowledge system capable of short-term operational decisions and long-term strategic decisions. CRBT sits at the center of the process.

All this data then facilitates short-term operational and long-term strategic decision-making undertaken by the strategy team. The

respondent indicated that he uses green to indicate something is on track, Amber to indicate something is slightly off-track, and Red to indicate something is going off-track. He notes that using these colours helps drive conversations about why something might be red and what that means.

In the qualitative interviews, respondents communicated through various visual aids to communicate knowledge and decisions, including Microsoft Visio, Flow charts, Diagrams, PowerPoint presentations, Demonstration environments, Dashboards, and Standard profit and loss heat maps. The respondents use visual tools and techniques, feedback, and collaborative workshops to ensure that SMEs can understand, agree upon, and refine the information provided for system configuration and process improvements. Vo and Kelemen (2014) also evidenced that visual communication assisted relevancy and accuracy. Bradel et al. (2013) and Kumar et al. (2017) confirmed collaborative sensemaking and communication through visualization.

The main themes of communication, verification, and process are illustrated in Figure 26. People, namely the SMEs and SEs, together with the technology (the LCS and Knowledge Base) and the data, use visualization to share, configure, agree on best practices, and assimilate the knowledge. Data Visualization was found to be central to the process and enabled actionable strategic and operational decision-making as depicted in Figure 24:

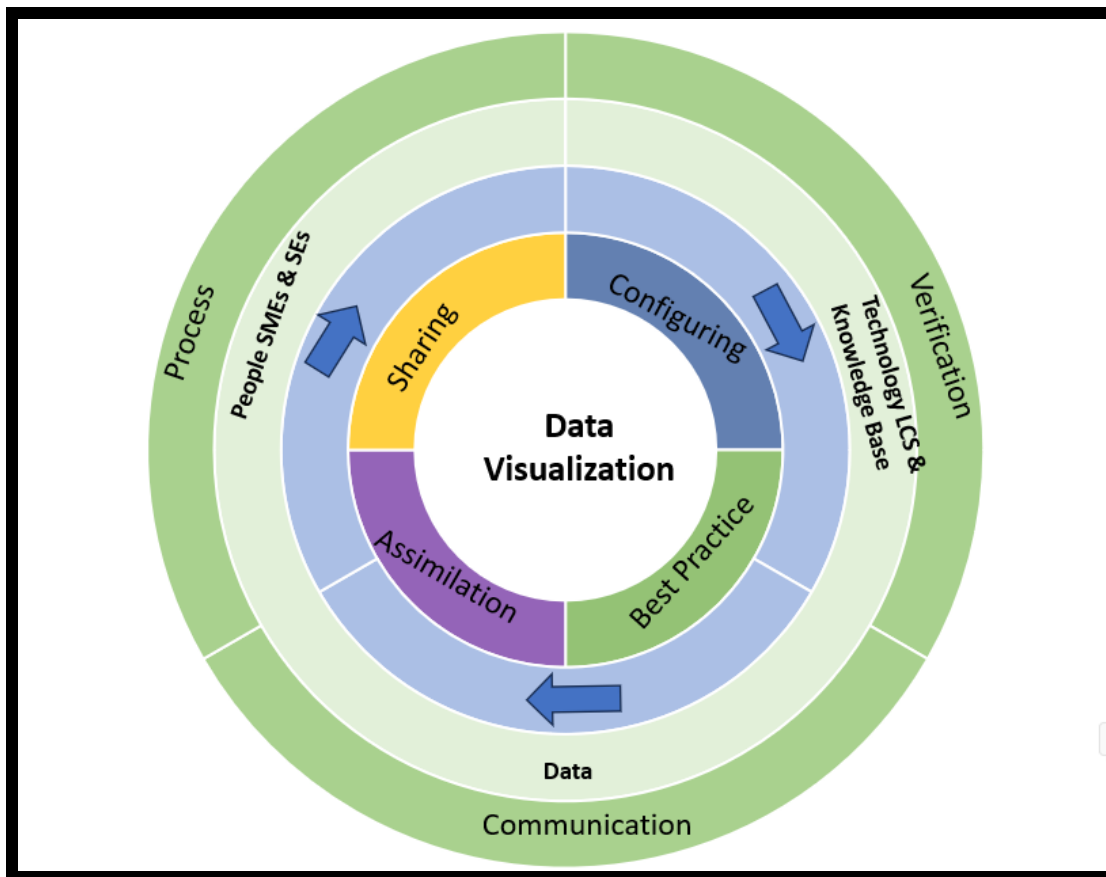


Figure 24: Actionable Decision-making enabled through Data Visualization.

6.4 Limitations of the Study

6.4.1. Delimitations

This section covers the boundaries of this research to render it manageable, and in this instance, the research is limited to the legal industry. It was focused on a qualitative study outlining SME and SEs' use of visualization for decision-making system implementations, but this could be extrapolated to any assumption automation project. The LC research was limited to one sector (legal) and one geographical region (United Kingdom) however, the SEs and SMEs had all worked in multiple geographical regions. The research study can, therefore, only infer limited quantitative generalizations to the legal industry sector. It

is recommended that further research could confirm the model across more industry sectors and regions.

The research also focused on an interdisciplinary team of SEs and SMEs in management, finance, technology, process, and big data analysis. This could, however, be extended to a much wider audience of stakeholders within the firm. It could also be extrapolated to other service industries requiring budgeting and forecasting.

6.4.2 Limitations

This research was subject to some limitations and potential sources of error. When groups of LCSs were examined, the Leaders group had a high standard deviation, indicating a relatively high variance in the financial performance within the group. It would have been better to have representatives of all the groups (Leaders, Challengers, Niche, and Visionaries) referred to in the Gartner research. This would have provided richer, more representative data on all four groups: Leaders, Challengers, Visionaries, and Niche.

The introduction of LCSs cannot solely explain revenue increase. Further studies should include more variables that may assist in explaining the rise in revenue, such as practice management areas, region, economic context, political context, etc. Secondly, the top firms in revenue may have more money and can spend a significant portion of their budget on system implementation. The successful implementation itself in terms of investment planning, coordination, and best practice, rather than what is being implemented, therefore contributing to the increase in revenue. Shabbir and Gardezi (2020) found that implementation practices such as planning, investment, coordination, control, connectivity, compatibility, modularity,

technology management knowledge, business knowledge, and relational knowledge need to be controlled for, and this was not possible due to a lack of detailed implementation variables in the dataset. Further research is required to examine the effect of this broader range of variables; however, for this research's purposes, a springboard was provided to investigate the role of LCSs and workflow in increasing revenue.

This LC research was, however, limited in scope and could not account for other variables that may also have contributed to those firms' increase in profitability. Recommendations for future research include accounting for other variables, such as the effect of the skills and experience of the implementation team and the maturity of the firm implementing the LCS.

There are a few limitations of RBT. Firstly, RBT cannot answer why and how some firms gain a competitive advantage in a dynamic business environment (Kleinschmidt, de Brentani, and Salomo, 2007). Intangible assets and capabilities are difficult to measure and, therefore, quantify. RBT has been criticized for providing a process but needs step-by-step guidance to acquire these internal dynamic capabilities. The value creation idea proposed based on this theory regarding valuable resources is self-verifying and not empirically testable (Kozlenkova, Samaha, and Palmatier, 2014; Priem and Butler, 2001). RBT has also been criticized for being static and failing to tackle organizational activities' effect on resource effectiveness over time (Kozlenkova, Samaha, and Palmatier, 2014). However, Peteraf and Barney (2003) felt that this had been addressed by adding policies and organizational processes. Finally, RBT ignores exogenous resources and assumes that only endogenous factors are essential to driving competitive advantage. Exogenous factors may offer potential

as advantageous capabilities (Lewis et al., 2010), so the researcher focused on CRBT to address this context insensitivity.

Finally, at the outset of the research GAI and LLM's were relatively new. As an outcome of this research, the researcher has suggested training an LLM to automate the planning capabilities, with the use of visualizations to reduce the complexity of the data for the SME, to interact with. However, LLMs run the risk of 'model collapse,' which occurs when you train models on vast datasets, and they eventually produce material that feeds back into the training data. If mistakes are made, then these are amplified over time and lead to a degenerative process whereby Models forget. This can be thought of as a form of senility.

6.5 Summary

A common theme in this research is how technology, people, and data-enabled communication between the teams responsible for Information Systems, KM, Communications Technology, Financial Management, and Strategy. Visualization is also used for cultural buy-in to discuss critical processes and gain cultural buy-in. Visualizations help SMEs understand output reporting and critical drivers, aiding in deciding on a standard data model.

Central to this is CRBT, specifically the dynamic capability enhanced by data visualization. Visualization can assist with communication, process, and verification. In terms of communication, visuals like reports can help distinguish between different areas and processes and convey statistics and requirements. Visualization can also aid in the process by showing different steps or procedures. Lastly, visualization can assist in verification by providing a clear overview of

what has been done and allowing for comparison with expected outcomes.

Visualization adds to the bundle of dynamic capabilities in a firm, enabling actionable decisions and ultimately increasing a firm's competitiveness.

This chapter has interpreted the findings and discussed these in terms of the themes. The future of visualizations, as well as the implications, have been explored. Finally, the limitations of the study were outlined.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This chapter concludes the thesis. The research objectives are unpacked to understand the sensemaking of large datasets and the findings. The results and the theoretical contribution are brought together in a visual process, enabling dynamic capability. The three roles of visualization in this research are expanded on. A common theme of technology, people, and data-enabled communication contributed is expounded on. Implications and recommendations for management are outlined. Recommendations for future research include delimitations, limitations, and contributions. The research is wrapped up in the concluding remarks. The interdisciplinary approach is unpacked.

7.2 Research Objectives

This research set out to establish how law firms make decisions by combining data, technology, and people as a bundle of resources and capabilities to enable decision-making.

The associated research objectives are as follows:

1. Determine which types of information technology (specifically information systems supporting decision-making) contribute to the competitiveness of a firm.
2. Develop a process model of how visualization and information systems are used to facilitate human decision-making.
3. How does the proposed model replicate strategic and operational decision-making in practice?

The research established:

- visualization aids the sharing of expert knowledge on the subject matter by ascribing and conveying importance to some underlying principles.
- visualization aids explicitly in making rules relating to sequence and processes.
- visualization aids in the agreement between SMEs and SEs regarding best practices.
- visualization aids the assimilation and adoption of the new processes by SMEs and SEs.
- interdisciplinary teams use visualization for communication, verification, and process during the implementation cycle.

7.3 Contributions of the Research

The research has made a methodological contribution where interdisciplinary communication through visualization produced different outcomes than those generated when working in traditionally siloed areas. This interdisciplinary visualization is promoted as the ideal tool for dynamic communication and making actionable decisions to enable working to improve pace, communication, and quality.

The novelty of this research can be demonstrated in two significant ways. Firstly, the research assesses the role of data visualization as a form of interdisciplinary communication to facilitate strategic management decision-making. Secondly, the research considers the theory around data-driven decision-making systems and strategies to enhance competitive firm advantage. It clarifies the understanding of the operational and strategic capabilities required for managing a firm and ultimately increasing revenue.

7.3.1 Contribution to Contingent Resource-Based Theory

Objective 1: Determine which types of information technology (specifically information systems supporting decision-making) contribute to the competitiveness of a firm.

Role of LCS in Profitability: The research emphasizes a process centered around Low Code Systems (LCS) to enhance profitability, highlighting the importance of execution capabilities and completeness of vision in driving competitiveness. This is supported by Coombs (2020) and Obitade (2019).

Firm Categorization: Firms implementing LC workflow systems are categorized based on their vision and execution into visionary, leaders, niche, or challengers. This categorization underlines the need for data decision-making systems that are descriptive, predictive, explicit, visual, accurate, and automated with both operational and strategic capabilities.

Initial results of this research were published in a paper by Carol E Cuthbert and Noel Pearse entitled *The Strategic Use of Low Code Systems*, presented at the 16th International Conference on Education and Information Systems, Technologies and Applications (Cuthbert and Pearse, 2021).

Objective 2: Develop a process model of how visualization and information systems facilitate human decision-making.

The thesis addresses the limitations of RBT by developing a process around LCSs based on CRBT (Ferraris et al., 2019; Helfat et al., 2003; Peteraf and Barney, 2003). It highlights how firms use LCSs and

workflow systems to increase revenue and facilitate actionable decision-making. The process incorporates strategic and operational capabilities to make tacit assumptions explicit in budgeting, utilizing the model to explain visualization's role in sharing, agreeing on process and configuration, agreeing on best practices, and assimilating the knowledge going forward. This is facilitated through visualization in communicating, conveying, and structuring the process and assisting with verifying complex data.

RBT explains competitive advantage through VRIO resources and capabilities, focusing on resource allocation and deployment for short to medium-term gains (Helfat et al., 2003; Kozlenkova, Samaha, and Palmatier, 2014; Ron and Helfat, 2003). Dynamic organizational capabilities influence visualization to support managerial decisions and firm performance amid changing conditions (Ron and Helfat, 2003). Firms gain a competitive advantage by building new capabilities, recombining resources, and responding to market demands (Ferraris et al., 2019).

Firms achieve competitive advantage by building capabilities, such as domain knowledge and skills, and accumulating intangible assets (Kozlenkova et al., 2014; Makadok, 2001). BDA aligned with business strategy enhances firm performance, facilitating innovation and expansion of offerings (Akter et al., 2016; Seddon and Currie, 2014; Wright, Stone, and Aravopoulou, 2019). Visualizations support data exploration, pattern identification, and strategic action to unlock firm value and increase profitability (Ferraris et al., 2019).

Dynamic Capabilities and Competitive Advantage: Visualization is integrated into dynamic capabilities, enhancing competitive advantage through the sensemaking of large data sets, verification of budgeting assumptions, and

communication of strategic decisions. Firms are presented with a methodology for defining, verifying, and refining budgeting assumptions to drive competitive advantage.

This objective was supported by the presentation of a Strategic Data Pattern Visualization paper at the 18th International Multi-Conference Society, Cybernetics and Informatics (IMSCI). This was also published in the Journal of Systemics, Cybernetics, and Informatics (Cuthbert and Pearse, 2022).

Objective 3: Determine whether the process model replicates what happens in practice

Visualization aids in interdisciplinary communication, verification, and sensemaking of large datasets, enhancing budget accuracy and enabling strategic decisions (Allen et al., 2014; Nowotny, Scott, and Gibbons, 2003). Visualization assists with sensemaking, verification, and communication, as supported by Coombs et al. (2020).

Visualization balances autonomy and control for expert decision-makers, aligning values, task attributes, and risk tolerance (Chiang et al., 2018).

A qualitative study validated the benefits of visualization, making tacit budgeting assumptions explicit, addressing budgeting process challenges, and improving accuracy. This was also supported by Nikulina (2020) and Minkov (2010). An interdisciplinary team of SMEs, SEs, and technology and management stakeholders made sense of complex data to enable efficient strategic and operational decisions and validate expert knowledge assumptions during decision-making. Interdisciplinary communication through data visualization benefited SMEs during the system implementation cycle.

This objective was supported by an article entitled, Data Visualization of Budgeting Assumptions: An Illustrative Case of Interdisciplinary Applied Knowledge (Cuthbert, Pearse, and Bradshaw, 2024). This was presented at the Abstract Proceedings for the First Meeting of the International Association for Transdisciplinary Communication (SFTC) held in the context of the IMSCI 2023 and sponsored by ISIS. This was also published in the Journal of Systemics, Cybernetics, and Informatics (Cuthbert, Pearse, and Bradshaw, 2024).

In summary, the research contributed to the literature by integrating LCSs with CRBT, enhancing competitive advantage through dynamic capabilities, emphasizing the critical role of data visualization, leveraging intangible resources and BDA, and validating these concepts through practical application.

7.3.2 Contribution to Management

Objective 1: Role of LCS Determine which types of information technology (specifically information systems supporting decision-making) contribute to the competitiveness of a firm.

LCS and, specifically, workflow systems enhance competitiveness. Firms can, therefore, consider implementing LCS and, specifically, workflow systems to increase profitability.

Objective 2: Develop a process model of how visualization and information systems are used to facilitate human decision-making.

The research explored the dynamic capability of knowledge through visualization, emphasizing the need for process automation and strategic alignment of technological and management capabilities (Ajgaonkar, Neelam, and Wiemann, 2022; Shan et al., 2022; Troise et al., 2022).

Visualization aids in verifying decisions, communicating large amounts of information efficiently, and enabling firms to adapt to changing environments, enhancing financial performance and strategic planning (Hayajneh et al., 2022; Saleem et al., 2021).

Objective 3: Determine Whether the Process is Replicated in Practice

The research underscores the importance of optimizing Big Data Analytics (BDA) capabilities with visualization as a verification, process enabler, and communication tool (Ferraris et al., 2019; Akter et al., 2016). Visualization supports management communication, enhances unconventional problem-solving, and improves firm performance by making big data analytics more agile and accessible (Bhatti et al., 2022; Huang, Song, Xie, Li, and He, 2022). The knowledge process detailed how visualization facilitates knowledge creation, sharing, and management (Nonaka, 1994).

Visualization functions as a process enabler and verification tool in workflow systems, highlighting its role in interdisciplinary communication and strategic decision-making (Balfe et al., 2015; Chiang et al., 2018). The research emphasized the broader implications of an interdisciplinary approach, particularly in legal firms, illustrating how data analysis and visualization can enhance decision-making and resource mobilization (Blackburn et al., 2015; Delen and Demirken, 2013). Visualization is central to the work of data scientists, aiding in effective decision-making and contributing to firm performance through actionable insights.

Actionable Knowledge: The research contributes to understanding how an interdisciplinary strategic leadership team can be provided with actionable knowledge for decision-making, given vast data sets and dynamic environments. Firms and firms must communicate and optimize resource configurations and use visualization in planning systems, including its role in employing it to analyze configurations. The adoption of visualization

methods in resource-based frameworks highlights their potential to enhance decision-making in dynamic environments, which aligns with the principles of CRBT and is, therefore, worth exploring despite being niche.

The research highlights the contribution of visualization to codifying and sharing knowledge, with future phases involving advanced forecasting techniques such as Monte Carlo simulations, regression analysis, and sensitivity analysis (Blackburn et al., 2015; Delen and Demirken, 2013). Visualization assists firms in making informed decisions about patterns or trends, aiding revenue and cash flow planning by modeling various scenario outcomes. A clear understanding of SMEs and SEs assumptions ensures successful implementation. Visualization improves the accuracy of the budgeting process and frees up time for experts to focus on value-adding activities. The process that emerged during the literature review was accurate; it highlights visualization's central role in the knowledge process. In summary, the research highlights the critical role of visualization in forecasting and planning, recommendations for future interdisciplinary research, advancements in planning and forecasting systems through AI integration, and the importance of visualization as a communication, verification, and process tool.

7.4 Research Profile

The researcher (Carol E Cuthbert) has written four journal articles with eight citations and an H index of 2—[Scholarly Profile](#) of Carol E Cuthbert. Three of the publications are relevant to this research.

On two occasions, Carol E Cuthbert spoke at a Tools and Techniques session for the International Institute of Business Analysis (IIBA). The first

time, on the 13th of June 2024, her topic was The Use Cases of AI in legal technology. The second time, on July 27, 2024, she was part of a panel on AI.

7.5 Recommendations for Further Research

Future research should extend findings to other areas and industries where LCs can improve competitiveness. Further research could also examine what has happened in the legal industry since 2021. More recently, Gartner's research revealed that Microsoft has played a prominent role in developing LCS, as evidenced by Figure 25 below.



Figure 25 Magic Quadrant for Analytics and Business Intelligence Platforms (Gartner Incorporated, 2024).

This focus on technology, data, and people and their interrelationship should be extended to enhance CRBT theory with a focus on dynamic capabilities. Future research should extend findings to other areas where tacit knowledge must be communicated and shared across disciplines. As technology is changing rapidly, the interaction between the experts, technology, and data should be further explored as bias, security, data confidentiality, and the psychology of interacting with machines becomes more prominent.

Developing LLM/application integration to automate refining budgeting and forecasting assumptions, resulting in more accurate forecasts and various scenario models. AI agent workflows, including iterative processes, are recommended to improve AI performance in forecasting and planning (Dong et al., 2024).

These methods could be applied to other interdisciplinary work, enhancing budgeting and forecasting tools with regression analysis, Monte Carlo simulations, time-series analysis, sensitivity analysis, and forecast error analysis. Future models could be trained on more varied datasets to test their potential. Agentic workflows and RTNet to mimic human decision-making could improve the results.

An LLM use case involving visualizations (for example, a profit and loss heat map) to simplify complex data for the SEs was introduced to the SEs as it evolved from the research. This enables them to select which underlying assumptions produced the best forecasts and budgets

(verify the forecasted/ budgeted data against actuals). From an application point of view, one would then use generative AI to feed in the assumptions and visualization of complex data (into the prompt area). AI refers to machines' simulation of human intelligence and includes things like Robotics, Computer Vision, Voice recognition, Natural Language Processing (NLP), and predictive analytics. These processes include learning, reasoning, and self-correction. Generative artificial intelligence (GAI) is a subset of AI that uses AI to create new content like text, images, video, code, and movies by learning patterns from existing data. ChatGPT is an example of this.

One could use one of the standard ChatGPT or FLAN-T5 models and add another layer with the client's data that doesn't train the primary model and disappears to account for privacy legislation, etc.) and allow the budgeting/ forecasting users to select the best assumptions (by providing an application interface on top of the model to enable them to interact with the application for example Tagetik. This way (with some training interaction between the SMEs and the AI), more automated budgets and forecasts can be produced – until the context changes and new underlying assumptions are needed. This would always be required as forecasts are becoming more complex, with, for example, the move away from the billable hour to other billing forms (fixed price/ outcome driven), making forecasting and planning more complex. The main thought is to automate the planning and forecasting process. Underlying assumptions are configured to generate complex data visualizations, simplify the data, and enable them to make data-driven decisions in training the models (based on the most optimal assumptions for the current specific context).

7.6 Closing Remarks

Data visualization plays a role in the relationship between firm resources and profitability by revealing data patterns that provide insights that lead to management actions. There are several applications of this process for using data visualization by decision-makers. Cognizance of the task attributes needs to feed into the research agenda, as not all tasks are equally suited to visualization; for example, heat maps are suited to complex data, simplifying two or three data points.

The dynamic capability, as recognized by Eisenhardt and Martin (2000), is, in this instance, the ability of the firm to adjust to the context and refine its assumptions dynamically to harness the knowledge for strategic management purposes. Refining the assumptions and confirming their accuracy in arriving at the correct revenue and expenditure figures is automated using visualization.

Enhancing planning accuracy through visualization is an area that needs to be more researched and addressed. The main contribution of this research is highlighting the value of variance heat map visualizations and symbol workflows in making budgeting assumptions explicit, thereby enhancing budgeting accuracy.

The research intended to discover if visualization enabled interdisciplinary communication in an interdisciplinary team. This was threefold in terms of functioning: verification of the assumption accuracy, achieving process control, and facilitating interdisciplinary communication in general, hence facilitating the management aspect of technological improvements. In this instance, as highlighted by Thorén and Breian (2016), the pragmatic problem-solving capacity research of visualization was also evidenced.

The main contribution of this research is highlighting the value of variance heat map visualizations and symbol workflows in making budgeting assumptions explicit, thereby enhancing budgeting accuracy. Furthermore, the work contributes a process that connects data visualization and performance outcomes. Data visualization is a primary resource that aids actionable decisions by revealing insights from data patterns. The research proposes balancing autonomy and control for expert decision-makers, aligning values, task attributes, and risk tolerance. The process recommends testing through structured equation models and case studies and suggests expanding research to other decision-making systems and ethical considerations.

The research's implications extend to interdisciplinary visual communication, giving departments access to the benefits of data science. Data visualization mediates the link between firm resources and profitability by translating data patterns into actionable insights. The process prompts management to foster an environment that empowers data scientists and expert decision-makers, aligns with organizational values, considers task suitability, and incorporates risk management. The research calls for further validation, more comprehensive application, and exploration of ethical dimensions.

The potential use of data analysis and visualization in legal firms has been illustrated. An argument has also been developed emphasizing the centrality of data visualization to the data scientist's work as a mechanism to mobilize resources for effective decision-making and action-taking that contributes to firm performance.

While RBT has been extensively studied over the last twenty years, the results could have been more sensitive to context, and the role of visualization should have been addressed. The research tried to

understand how firms respond when sensemaking large data sets to enable actionable decisions. The research studied this in a context where previously siloed groups were required to spend limited time reviewing statuses and variances from previous positions to make actionable decisions on where to provide resources and what actions to take.

Progress has been made to include numbers and data in organizational theory and process testing. Our research looked at CRBT in a new way. Instead of just researching it from one angle, combine ideas from different research areas. This research explored how this theory applies to legal services businesses. These businesses need BDA capabilities to sense data in dynamic circumstances. The research found that teams of experts from different fields often work together in the legal world. They use pictures and graphs to understand big sets of information and make intelligent choices for long-term strategic plans and operational day-to-day tasks.

Visualization research combines ideas from different fields through interdisciplinary communication. Firstly, it helped a diverse group of experts understand big data sets by turning them into pictures, making it easier for them to make essential choices. In the second instance, the real-world problem required input from many different areas of knowledge.

Vast and complex data requires visualization for sensemaking and integrating knowledge from different angles, progressing our understanding of organizational theory. Data visualization through interdisciplinary communication has extended our dynamic capability and organizational theory. The research makes recommendations for

solving real problems. Finally, ideas are provided for advancing research in this area.

The research found that visualization aids in conveying knowledge by fostering common understanding, aids configuration and process agreement by making processes explicit, aids best practice agreement by facilitating global agreement on best practices, and aids assimilation by ensuring adopted processes and rules are integrated into knowledge-based systems. Furthermore, the application of the SECI model was extended through this research to improve budgeting assumptions and highlight the potential role of visualization during the SECI knowledge creation and sharing phases. This thesis is focused on interdisciplinary visual communication enabling budgeting assumption visualization and its contribution to improve a firm's competitive advantage within the CRBT process.

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APPENDIXES

Table 10 Interview Questions for SMEs

Phase	Findings from the Illustrative Case	Related Proposition	Interview Questions
<p>Involves tacit-to tacit communication, passing knowledge through practice, imitation, and observation.</p>	<p>Knowledge of planning and budgeting is shared.</p>	<p>Visualization aids the process where everyone shares their subject matter expert knowledge by ascribing and conveying importance to some underlying principles. The profit and loss heatmap and the visualized workflows are examples of this.</p>	<p>How do you convey and adapt what you base your subject matter expert decisions on to other SMEs within your region? Please also elaborate on the use of visual clues to convey this knowledge when conveying workflow understanding. Please also email me generic examples of the visualizations you use.</p>
<p>Involves tacit-to-explicit communication and is often challenging.</p>	<p>Information is provided and coded/ configured.</p>	<p>Visualization aids the process by explicitly making rules relating to sequence and processes. Complex data is simplified.</p>	<p>What information do you provide to the SEs to code the workflow and assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in your region. Please also email me generic examples of the visualizations you use.</p>
<p>Includes communication from explicit knowledge to explicit knowledge. Results are aggregated and compared to provide new insights.</p>	<p>SME and SE best practice information is agreed upon.</p>	<p>Visualization aids the phase by facilitating agreement between SMEs and SEs on best practices.</p>	<p>How is the information you provided to configure the system and drive the calculations agreed upon by SMEs? Are there forums or workshops to facilitate this? Please also elaborate on the use of Visualizations to concur with this knowledge. Please also email me generic examples of the visualizations you use.</p>

<p>Involves taking explicit knowledge back to tacit knowledge and embedding this through doing and assimilating the knowledge as one's own (Nonaka and Toyama, 2015).</p>	<p>Information is assimilated and becomes ingrained.</p>	<p>Visualization aids in the assimilation and adoption of new processes by SMEs and SEs. For example, the workflow ensures stepped compliance regarding the sequence and person processing in the knowledge-based systems. Visualization also plays a role in simplifying complex information for the SMEs.</p>	<p>How do you, as an individual, make the new knowledge your own and apply this within the next budgeting and forecasting cycle? What visual cues or tools assist the process? Please also email me generic examples of the visualizations you use.</p>
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Table 11 Question Matrix of Interview Questions matched against proposition.

Questions for all Interviewees	General	Proposition 1: Visualization aids the process where everyone shares their subject matter expert knowledge by ascribing and conveying importance to some underlying principles.	Proposition 2 Visualization aids the process by explicitly making rules relating to sequence and processes. Complex data is simplified.	Proposition 3: Visualization aids the n phase by aiding agreement between SMEs and SEs of best practice.	Proposition Visualization aids the assimilation and adoption of new processes by SMEs and SEs.
How many years of experience do you have implementing low code/ workflow systems?	X				
How do you use data Visualization within your project	Qualifying question				
How have heat maps been used to provide feedback to SMEs	X				
How do you convey and adapt what you base your subject matter expert decisions on to other SMEs within your region? Please also elaborate on the use of visual clues to convey this knowledge when conveying workflow understanding.		X			
What information do you provide to the SEs to code the workflow and assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in your region.			X		

<p>How is the information that you provided to configure the system and drive the calculations agreed upon by SMEs? Are there forums or workshops to facilitate this? Please also elaborate on the use of Visualizations to concur with this knowledge.</p>				X	
<p>How do you, as an individual, make the new knowledge your own and apply this within the next budgeting and forecasting cycle? What visual cues or tools assist the process?</p>					X

Table 12: Interview Questions for SEs

Phase	Findings from the Illustrative Case	Related Proposition	Interview Questions
<p>Involves tacit-to-tacit communication, passing knowledge through practice, imitation, and observation.</p>	<p>Knowledge of planning and budgeting is shared.</p>	<p>Visualization aids the process where everyone shares their subject matter expert knowledge by ascribing and conveying importance to some underlying principles. The profit and loss heatmap and the visualized workflows are examples of this.</p>	<p>How do you convey and adapt what you base your SE decisions on to other SEs within your region? Please also elaborate on the use of visual clues to convey this knowledge when conveying workflow understanding. Please also email me generic examples of the visualizations you use.</p>
<p>The phase involves tacit-to-explicit communication and is often challenging.</p>	<p>Information is provided and coded/ configured.</p>	<p>Visualization aids the process by explicitly making rules relating to sequence and processes. Complex data is simplified.</p>	<p>What kind of information do the SMEs provide you to code the workflow and assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in your region.</p>
<p>The phase includes communication from explicit knowledge to explicit knowledge. Results are aggregated and compared to provide new insights.</p>	<p>SME and SE best practice information is agreed upon.</p>	<p>Visualization aids the phase by facilitating agreement between SMEs and SEs on best practices.</p>	<p>How is the information that you are provided with to configure the system and drive the calculations agreed upon by SMEs? Are there forums or workshops to facilitate this? Please also elaborate on the use of Visualizations to concur with this knowledge. Please also email me generic examples of the visualizations you use.</p>
<p>Involves taking explicit knowledge back to tacit knowledge and embedding this through doing and assimilating the knowledge as one's own (Nonaka and Toyama, 2015).</p>	<p>Information is assimilated and becomes ingrained.</p>	<p>Visualization aids in the adoption of new processes by SMEs. For example, the workflow ensures stepped compliance regarding the sequence and person processing in the knowledge-based systems. Visualization also plays a role in simplifying complex information for the SMEs.</p>	<p>How do you, as an individual, make the new knowledge your own and apply it within the next budgeting and forecasting system configuration cycle? What visual cues or tools assist the process? Please also email me generic examples of the visualizations you use.</p>

Table 13: Interview Questions matched against Proposition.

Questions for all Interviewees	General	Proposition 1: Visualization aids process where everyone shares their subject matter expert knowledge by ascribing and conveying importance to some underlying principles.	Proposition 2 Visualization aids the process by explicitly making rules relating to sequence and processes. Complex data is simplified.	Proposition 3: Visualization aids the phase by aiding agreement between SMEs and SEs of best practice.	Proposition Visualization aids the assimilation and adoption of new processes by SMEs and SEs.
How many years of experience do you have implementing low code/ workflow systems?					
How do you use data Visualization within your project	Qualifying question				
How have heat maps been used to provide feedback to SMEs					
How do you convey and adapt what you base your SE decisions on to other SEs within your region? Please also elaborate on the use of visual clues to convey this knowledge when conveying workflow understanding.					
What kind of information do the SMEs provide you to code the workflow and assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in your region.					
How do you, as an individual, make the new knowledge your own and apply it within the next budgeting and forecasting system configuration cycle? What visual cues or tools assist the process?					
How do you, as an individual, make the new knowledge your own and apply it within the next budgeting and forecasting system configuration cycle? What visual cues or tools assist the process?					X

Table 14: Responses Respondents 1 – 4

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
	Summary	<p>Conveying Workflow Understanding:</p> <ul style="list-style-type: none"> Visualization helps in understanding workflows, especially in data conversion and testing. It highlights areas where data passes or fails during the conversion process. <p>Training and Communication:</p> <ul style="list-style-type: none"> Visual aids are crucial for training subject matter experts (SMEs) to understand new processes and data. Provides system experts with detailed information about the data conversion process, necessary reports, and critical areas for checking. <p>Implementation and Testing:</p> <ul style="list-style-type: none"> Visualization tools, such as data mapping and logging, are vital for identifying issues and areas for refinement in the data conversion process. Visual cues, like maps of data conversion, aid 	<p>Use of Visual Aids:</p> <p>The respondent uses various visual aids such as Microsoft Visio, flow charts, diagrams, and PowerPoint presentations to convey information.</p> <p>Visual tools explain complex processes, like billing workflows, and ensure consistent understanding among regional SMEs.</p> <p>Consistency and Standardization:</p> <p>Visual tools are employed consistently across projects to help those unfamiliar with previous demonstrations understand the processes.</p> <p>Despite the extensive use of visual aids, there is a lack of standardized notations for daily processes, making these tools essential for communication.</p> <p>Workshops and Demonstrations:</p> <p>In-person and remote workshops are conducted to present findings and gather user feedback.</p>	<p>Methods of Conveying Expertise:</p> <p>The respondent uses process diagrams, flow diagrams, reporting examples, and standard profit and loss heat maps. Emphasizes simplicity and clarity in conveying information using PowerPoint and process flow diagrams.</p> <p>Purpose and Tools:</p> <p>Visualization helps in understanding workflows through tools like waterfalls and dashboards.</p> <p>Aids in understanding the business case, agreeing on standardization, and determining necessary inputs.</p> <p>Information for System Experts:</p> <p>Provides detailed information on business drivers, key milestones, and decision rationales.</p> <p>The respondent uses examples of reporting and visualizations to convey this information.</p>	<p>Use of Clear and Concise Language:</p> <p>Emphasizes the importance of using clear and concise language when conveying expert decisions to other SMEs.</p> <p>Visual Aids and Examples:</p> <p>Utilizes diagrams, flowcharts, and other visual representations to demonstrate workflows and processes.</p> <p>Highlights essential information with symbols or colours to enhance clarity and effectiveness.</p> <p>Encouraging Feedback and Adaptation:</p> <p>Encourages feedback and questions from SMEs and is open to revising and refining approaches based on their input.</p> <p>Tools and Techniques:</p> <p>Provides visual workflows, report layouts, and output reports to system experts for coding workflows and assumptions.</p> <p>Uses PowerPoint, graphics, highlighters, and visual cues to convey important information.</p> <p>Employs Power BI for data</p>

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
		in process verification and communication.	<p>Demonstration environments show out-of-the-box functionalities, helping users visualize potential solutions.</p> <p>Feedback and Adjustments: Post-implementation, user feedback is collected and used to make necessary adjustments. Information gathered is presented during project closure meetings using visual tools like PowerPoint and Excel.</p> <p>Reporting and Colour Coding: The respondent uses a reporting tool with a dashboard with colour-coded tiles to visually represent different information.</p> <p>Crucial Role of Visualization: Visualization is essential for effective communication, especially for complex processes or concepts. Visual aids are considered an absolute must in day-to-day work, and the respondent emphasizes the</p>	<p>Employs dashboards and interactive tools for effective communication.</p> <p>Structured Meetings and Reviews: Holds structured meetings and reviews to ensure alignment on configuration and communication. Uses visualizations to verify information accuracy and highlight areas needing attention.</p> <p>Workshops and Cultural Buy-In: Facilitates workshops to discuss and agree on critical processes and gain cultural buy-in. Uses visualizations to help SMEs understand output reporting and critical drivers, aiding in deciding on a standard data model.</p> <p>Simplicity and Focus: Keeps the process simple and focused on business variables for effective implementation. Visual tools like waterfalls and heat maps track</p>	<p>visualization and representation.</p> <p>The respondent uses colour coding and icons to indicate variances and represent different steps in the process.</p> <p>Workshops and Collaboration: Conducts workshops where SMEs from different regions agree on system configuration and calculations. Uses visualizations in workshops to aid understanding, such as colour-coded reports and flow arrows to show information flow.</p> <p>End-of-Cycle Reviews: Uses PowerPoint and various visual representations like graphs and heat maps to highlight achievements and areas needing improvement at the end of a cycle.</p> <p>Visual summaries confirm the information and make necessary adjustments for the next budgeting and forecasting cycle.</p> <p>Communication, Process, and Verification:</p>

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
			<p>necessity of having visual cues in presentations and workshops.</p> <p>Conclusion: Visualization is critical for conveying complex information, ensuring consistency, facilitating feedback, and effective project communication. Despite the lack of standardized notations, the respondent relies heavily on visual aids to communicate with regional SMEs and other stakeholders.</p>	<p>budgeting and forecasting cycles.</p> <p>Future Applications: Suggests fine-tuning processes based on previous cycles' experiences and learnings. Potential use of automation and AI for data analysis and trend identification.</p> <p>Effectiveness of Visualization: Visualization is effective for communication and verification, allowing for self-service understanding. It helps identify issues or successes immediately. Maintains discipline through structured meetings and reviews.</p> <p>Conclusion: Visualization is vital for communicating complex information, ensuring clarity and simplicity, and facilitating understanding and alignment among SMEs.</p> <p>Structured use of visual tools supports effective system configuration,</p>	<p>Visualization aids communication by distinguishing between different areas and processes and conveying statistics and requirements.</p> <p>The respondent helps in process understanding by showing different steps or procedures visually.</p> <p>Assists in verification by providing a clear overview of completed tasks and allowing for comparison with expected outcomes.</p> <p>Conclusion: Visualization is crucial for effective communication, understanding, and verification of complex workflows and processes.</p> <p>Using visual tools and techniques, feedback, and collaborative workshops ensures that SMEs can understand, agree upon, and refine the information provided for system configuration and process improvements.</p>

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
				process understanding, and continuous improvement in business practices.	
1	How many years have you worked implementing systems in the legal industry?	20+ years	7-8 years	20 years +	Four years
2	How do you convey and adapt what you base your subject matter expert decisions on to other SMEs within	Participant 2 mentioned that visualization can help convey workflow understanding, particularly regarding data conversion and testing. They also highlighted the importance of training to help SMEs understand new processes and data.	The respondent conveys their knowledge and decisions to other regional SMEs through various visual aids such as Microsoft Visio, flow charts, and diagrams. They also use PowerPoint presentations to present their findings visually. Additionally, they use demonstration environments to show how things would work out of the box. This helps people to visualize how they would want their solution to work. The respondent also mentioned	They explained that they convey their subject matter expertise to other SMEs within their region using various methods. These include process diagrams, flow diagrams, examples of reporting, and standard profit and loss heat maps. They emphasized the importance of keeping the information simple and easy to understand, using tools like PowerPoint and process flow diagrams. They also mentioned using visualization to help convey	In conveying and adapting expert decisions on subject matter to other SMEs within the region, I believe it's essential to use clear and concise language and to provide examples and visual aids where appropriate. This could include using diagrams, flowcharts, or other visual representations to demonstrate the workflow or process. Also, highlighting important information with symbols or colours can help convey the message more effectively. It's also important to encourage feedback and

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
	your region? Please also elaborate on using visual clues to convey this knowledge when conveying workflow understanding.		using colour coding to represent different things in their reporting tool visually.	workflow understanding, using tools like waterfalls and dashboards. The goal is to help everyone understand the business case for the system, agree on standardization, and then work back from there to understand what inputs are needed.	questions from other SMEs and to be open to revising and refining the approach based on their input.
3	What kinds of information do you provide to the system experts to code the workflow and assumptions? What	The participant explained that they provide the system experts with information about the data conversion process, the reports they want to use, and the areas that need to be checked. They also visualize the data conversion process, explicitly highlighting areas where the data is passing or failing. The respondent also suggests that visualization can help subject matter experts understand new methods and data that may be available to	The respondent explained that he provided information to the system experts through visual aids such as flow charts, diagrams, and PowerPoint presentations. He also uses Microsoft Visio and similar tools to draw and present these visuals. His information includes the step-by-step process of how the billing workflow would occur in his region and related settings. He also mentions that he uses the	The respondent explained that he provided information to the system experts to code the workflow and assumptions. This includes details about the business drivers, key milestones, and the reasons behind certain decisions. He also provides examples of reporting and visualizations to help convey this information. In terms of systems, he uses PowerPoint for process flow	The respondent provides information such as visual workflows of the process, layouts of the actual reports, and reports of the output to the system experts for coding the workflow and assumptions. They use PowerPoint, graphics, and highlighters to convey important information. They also use visual cues and symbols to indicate the process, whether an information step or a user input step. They use Power BI for data

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
	<p>systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in</p>	<p>more people than the legacy system. However, they note that visualizations are often only built later in the project.</p>	<p>same visual tools for consistency and to ensure that even those who have yet to see previous demonstrations can understand the process.</p>	<p>diagrams and other visuals, and he also uses dashboards and other interactive tools to help communicate the information. He uses structured meetings and reviews to ensure everyone is on the same page for configuration and communication. He also uses visualizations to verify the information's accuracy and identify areas needing attention.</p>	<p>visualization and representation. They also use colour to indicate variances and icons to represent different steps.</p>

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
	your region.				
4	How is the information that you provided to configure the system and drive the calculations agreed upon by SMEs? Are there forums or workshops to facilitate this? Please also elaborate on the use of Visualizat	The participant said that visualization is handy in the testing process, where they can see where the data is passing or failing and whether there are any issues. They also mentioned that visualization can help subject matter experts understand new processes and data that may be available to more people than the legacy system. However, they noted that visualizations are often only built later in the project.	The respondent explained that the information provided to configure the system and drive the calculations was agreed upon by subject matter experts (SMEs) by demonstrating and discussing the system. This process often involves using the same visual tools used in the project to ensure consistency. The respondent also mentions that they usually have workshops, some of which are in-person and some remote, to facilitate this process. In these workshops, they present their findings and get user feedback. However, the respondent also notes that they do not have standardized notations for daily processes, indicating that SMEs often rely on visuals to understand and agree upon the information.	The respondent explains that SMEs agree upon the information provided to configure the system and drive the calculations through cultural buy-in and understanding of the business case. This is often facilitated through workshops where key processes are discussed and agreed upon. Visualizations are also used to help SMEs understand the output reporting and the key drivers, which aids in deciding on the standard data model. The respondent emphasizes that the process should be kept simple and focused on the business variables for effective implementation.	SMEs agree upon the information provided to configure the system and drive the calculations through workshops where different regions with different requirements come together. Visualizations are used in these workshops to aid in the process. For example, reports can be shown in various colours to highlight important information and flow arrows can be used to show where the information is coming from and where it is going. The respondent also mentions that PowerPoint and graphs represent the information visually.

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
	ions to concur with this knowledge.				
5	How do you, as an individual, make the new knowledge your own and apply this within the next budgeting and forecasting cycle? What visual cues or tools assist the process?	Participant 2 responded that as an individual, she makes the new knowledge her own by testing it out in a controlled environment before implementing it fully. She also mentioned that visual cues, such as a map of data conversion, and tools like data mapping, testing, and logging are essential. She highlighted that data visualization through a standard interface can help identify issues or areas for refinement in the conversion process.	The respondent explained that once a product or solution has been implemented and tested, they get feedback from users. This feedback is then used to make necessary adjustments. During project closure meetings, they present all the information they've gathered. Visual tools like PowerPoint presentations and Excel are used to present this information. They also use a reporting tool, including a dashboard with tiles that convey different information. Some of these tiles are colour-coded to represent various things. However, the respondent mentioned there isn't much standardization in their day-to-day process, and they often must create visual aids for communication.	The respondent keeps things simple and uses visualization tools like PowerPoint presentations and flow diagrams to help understand and communicate the new knowledge. He also mentioned using waterfalls and standard profit and loss heat maps to track variances. In terms of applying this knowledge in the next budgeting and forecasting cycle, he suggested fine-tuning based on the experiences and learnings from the previous cycle. He also mentioned the potential use of automation and AI for data analysis and trend identification, especially when dealing with large volumes of data.	The respondent shared that at the end of a cycle, they use tools like PowerPoint to highlight what has been achieved and areas that need improvement. They use various visual representations like graphs, heat maps, or other tools to convey necessary information. This helps them make the new knowledge their own and apply it within the next budgeting and forecasting cycle. Additionally, they use visual summaries to confirm things and adjust as needed.

No	Question	Response Participant 1 TH	Response Participant 2 T N	Response Participant 3 CJ	Response Participant 4 RB
6	Does visualization assist with communication, process, or verification?	Participant 2 believed that visualization could assist in implementation with communication, process verification, and identifying gaps in data. They also mentioned that visualization could help subject matter experts understand new processes and data that may be available to more people than the legacy system. Additionally, they noted that visualization could help in testing processes where they could see where the data was passing or failing and whether there were any issues.	With visualization, especially when it comes to things like workflows, it is easier for people to visualize something. So, in my day-to-day work, it is an absolute must. I wish I could say 1,000%. Yes, to this, because. I must have a PowerPoint presentation if I am booked for a workshop on any module. I must have visual cues. From my experiences, visualization is crucial for effective communication, especially regarding complex processes or concepts.	According to the respondents, visualization is an effective tool for communication and verification. It allows for self-service, where people can go in and understand the information provided. It also helps identify any issues or successes immediately. Furthermore, it aids in keeping the discipline of having structured meetings and reviews.	Yes, visualization can assist with communication, process, and verification. In terms of communication, visuals like reports can help distinguish between different areas and processes and convey statistics and requirements. Visualization can also aid in the process by showing different steps or procedures. Lastly, visualization can assist in verification by providing a clear overview of what has been done and allowing for comparison with expected outcomes.

Table 15: SME Respondents 5 – 8
(One follow-up interview, three interviews)

No	Question	Response Participant 5 CD	Response interview 6 TH (Second Interview)	Response Participant 7 MS	Response Participant 8 TB
	Summary	<p>The respondent strongly believes in the use of visualization in the process of communication and verification in the implementation cycle. She finds it particularly useful in representing business processes that have various steps. Visualization also aids in the verification process with developers and subject matter experts. However, she notes that visualization is less intense in the verification process due to the need for detailed information and the top-level agreement between the parties involved.</p>	<p>The respondent added several points about visualization. She discussed the importance of breaking down requirements into components (must haves, nice to haves, and middle-of-the-road features) and visualizing these using a chart. This helps to identify any deficits or shortcomings in the responses from suppliers. She also mentioned using a mind map to identify possibilities within a process flow. Additionally, she talked about using a heat map to highlight unexpected values. Lastly, she suggested considering different colour values for visualizations to cater to individuals with colour blindness. She concluded that simple presentations and visualizations using tools like Excel are often the most effective.</p>	<p>The respondent explained that visualizations are used extensively in their implementation process. They use visualizations to document their standard workflows, to show the steps involved, and to help their clients understand their methods. They also use visualizations to track budgets and actuals and to identify variances. Furthermore, they use visualizations to document lessons learned from each project, which is used to improve their implementation methodology and delivery. The respondent also mentioned that visualizations aid communication and, ultimately, process.</p>	<p>The respondent believes visualization is an assertive communication, process, and verification tool. The respondent thinks visualization can help people understand complex systems and data flows more effectively than text. The respondent also mentions that visualization can be handy for communication, as more people can understand a picture than text. However, he also acknowledges that the value of visualization for verification might be less than for communication and process.</p>

No	Question	Response Participant 5 CD	Response interview 6 TH (Second Interview)	Response Participant 7 MS	Response Participant 8 TB
1	How many years have you worked implementing systems in the legal industry?	20+ years	20+	30+ years	Six years
2	How do you convey and adapt what you base your subject matter expert decisions on to other SMEs within your region? Please elaborate on using visual clues to convey this knowledge when	The respondent explained that they initially discussed the overall process and then came back with them to discuss all the options and details. They use the system to articulate the points of interest within that process and a workflow to say this is where the process is going. They use a combination of technical language, verbiage, and application screenshots within a presentation. They also use videos and swim lanes to represent the process flow and areas of responsibility visually. They provide detailed configuration documents that include all the variables associated with any	The respondent added several points about visualization. She discussed the importance of breaking down requirements into components (must haves, nice to haves, and middle-of-the-road features) and visualizing these using a chart. This helps to identify any deficits or shortcomings in the responses from suppliers. She also mentioned using a mind map to identify possibilities within a process flow. Additionally, she talked about using a heat map to highlight unexpected values. Lastly, she suggested considering different colour values for visualizations to cater to individuals with	The respondent explained that they use a combination of written word and visuals to convey their expert decisions to other SMEs within their region. They use workflow diagrams to show the steps of their standard workflows and document their process. They also organize a walkthrough of the client's process document to align it with theirs. The output of this process is a business design document that determines how the workflow will work for that client. They also use visualizations to help clients understand their data migration process,	The respondent shared that all programs need a standardized set of visuals. The use of visuals depends on the specific program and the needs of that program. For instance, they might use a high-level architecture diagram at the beginning of a program. They might also use a visualization of the data flow to understand how things should happen in the project. They've also used a visual representation of potential buckets of work. In terms of conveying their subject matter expert decisions, the respondent mentioned that they often work with someone familiar with the budget to feed that information into the process. They also mentioned

No	Question	Response Participant 5 CD	Response interview 6 TH (Second Interview)	Response Participant 7 MS	Response Participant 8 TB
	conveying workflow understanding.	configurations. They also keep a library of key customizations fulfilling a standard business process.	colour blindness. She concluded that simple presentations and visualizations using tools like Excel are often the most effective.	showing the values in their extract versus what is in the expert database.	that they usually have workshops or big program meetings to discuss best practices. However, they noted that the best practices might vary across different programs due to the unique nature of each program. Overall, the respondent emphasized the importance of visualization in conveying their decisions and understanding workflows. They also mentioned that they often must communicate their choices to people who might not be familiar with the legal industry, so they need to find ways to make their decisions and explanations more accessible and understandable to a broader audience.
3	What kinds of information do you provide to the system experts to code the workflow and	The respondent explains that they provide information to the system experts to code the workflow and assumptions through detailed discussions about the process, initial strategy documents updated as they go, and screenshots or videos demonstrating the		The respondent explained that they provide system experts with standard symbols and colours for workflow diagrams to ensure consistency across all processes, regardless of the task. They also provide a written description of the process. Before configuring	

No	Question	Response Participant 5 CD	Response interview 6 TH (Second Interview)	Response Participant 7 MS	Response Participant 8 TB
	assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in your region.	process. They also use visualizations to communicate the overall process flow. However, they rely more on text and spreadsheets for verification and detailed requirements.		the system and driving the calculations, they hold a workshop to review and document the regional variations of the process, which the client then reviews and signs off. They also use Excel validation sheets to visually show the values in the client's extract versus what is in the expert database, colour-coding it to indicate discrepancies.	

No	Question	Response Participant 5 CD	Response interview 6 TH (Second Interview)	Response Participant 7 MS	Response Participant 8 TB
4	<p>How is the information that you provided to configure the system and drive the calculations agreed upon by SMEs? Are there forums or workshops to facilitate this? Please also elaborate on the use of Visualizations to concur with this knowledge.</p>	<p>The respondent explained that the information provided to configure the system and drive the calculations was agreed upon by subject matter experts (SMEs) through an initial discussion about their current process. This information sets up configurations, switches, and options within each module. The SMEs also review and update these configurations and options as the implementation progresses. The respondent also mentions using forums and workshops to facilitate the agreement process. These forums and workshops are used to discuss the overall process with clients, to understand their process, and to align it with the system's process. Visualizations are also used to agree on this knowledge. The respondent mentions that visualizations, such as workflows and process summaries, represent the</p>		<p>The respondent explained that they always hold a workshop to review and document the regional variations of the process before configuring the system and driving the calculations. SMEs from all regions attend this workshop to ensure they understand all the requirements. The document created during this workshop is then reviewed and signed off by the client to ensure it accurately captures their requirements. This document is then used to configure the system. Regarding the use of visualizations to agree on this knowledge, the respondent mentioned that they use standard colours and symbols in their workflow diagrams, and they also use Excel validation sheets to visually show the values included in the client's extract versus</p>	<p>The respondents mentioned using visualization tools, particularly in communication, to help people understand the data flow and the rules. In terms of forums or workshops, Tim states that there aren't any standardized ones across all programs. The respondent also mentions that each program's implementation process is usually different, so there's no one-size-fits-all approach. However, he does note that they have run workshops to discuss best practices across various programs.</p>

No	Question	Response Participant 5 CD	Response interview 6 TH (Second Interview)	Response Participant 7 MS	Response Participant 8 TB
		business process and ensure a common understanding among SMEs and developers. These visualizations are also used to validate the system with the developers and the SMEs		what is in the expert database, colour-coding it to indicate any discrepancies.	
5	How do you, as an individual, make the new knowledge your own and apply this within the next budgeting and forecasting cycle? What visual cues or tools assist the process?	The respondent explains that as an individual, she makes the new knowledge her own by reviewing the updated strategy documents throughout the implementation process. These documents contain a combination of verbiage, application screenshots, and workflows. She also keeps a library of critical customizations that now fulfill a standard business process. This library includes visuals with icons and other presentation materials. When needed, she uses these visuals and her knowledge to facilitate the implementation process in the next budgeting and forecasting cycle.		The respondent explained that after completing a project, they have an internal review to document lessons learned, including areas where they went over budget, scope discrepancies, and the number and cost of change orders. This information is then used to improve their implementation methodology and delivery. Regarding visual cues or tools that assist this process, The respondent mentioned using slides to drive discussions during their internal review. Still, they only capture an output of verbal responses. The project manager leads with a summary of the project's performance, shared with	Visual cues or tools that assist the process include high-level architectural diagrams of the workflow and visual representations of potential workloads or buckets of work. Tim also mentions that he uses a high-level visualization of a plan or schedule to help understand the workflows and possible workload areas.

No	Question	Response Participant 5 CD	Response interview 6 TH (Second Interview)	Response Participant 7 MS	Response Participant 8 TB
				the client and the internal team.	
6	Does visualization assist with communication, process, or verification?	Visualization is powerful in assisting with process communication. It allows for representing business processes with various steps, making it easier to present and understand. To ensure the system's understanding, visualization is also used to a lesser extent in verification, particularly with the developers. However, verification has a lot of detailed text and spreadsheet-oriented validation.		The respondent responded that visualization aids communication and, ultimately, process. She explained that they have changed how they run their governance meetings to focus on critical areas using visualizations, making the governance calls more focused and efficient.	According to the respondent, visualization is handy for communication and process. He believes more people can understand a picture than massive amounts of text, making visual communication more accessible and practical. He also thinks that visualization can help people understand the data flow better and communicate a picture on paper more effectively than text. Regarding verification, Tim believes that visualization can be powerful, especially for complex systems with many interconnected parts. However, he also mentions that the value of visualization for verification might be less than for communication and process.
	Future of visualizations and the use of AI				

Table 16: System Experts (4x Interviews)

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
	Summary	<p>Simplicity is key: The respondent emphasizes keeping visualizations as simple as possible to ensure stakeholders can easily understand them. Purpose-driven: They focus on why something should be visualized rather than just putting information on screen because they can. Audience-centric: Visualizations are tailored to different stakeholder needs and levels within the business. Standard over custom: They prefer using standard, simple visualizations like bar charts and stack bar charts rather than creating custom, complex visualizations. Practical tools: Heat maps display 2-3 data points and allow drill-down capabilities. Communication tool: Visualizations are primarily used to tell a story</p>	<p>Limited Current Use: The respondent acknowledges using few visualizations in their implementation processes. They rely more on walking clients through the software rather than using separate visual aids. More Prevalent in Sales: Visualizations are used more in the sales process, but these don't typically carry over into the actual project implementation. Room for Improvement: The respondent recognizes they should use more visualizations in their processes. Evolving Expectations: The respondent notes that clients increasingly expect more visual representations of data, especially with tools like Power BI becoming more common. Mobile</p>	<p>Simplistic High-Level Plans: Uses a high-level program plan, often split by week, to convey the overall timeline from the current point to the end. Focus on Specific Areas: Sometimes, it provides detailed views on specific areas like the development cycle. Excel-Based Visualizations: Frequently uses Excel for visualizations due to its ease of manipulation despite having a comprehensive program plan. Higher-Level Information Presentation: Prefers presenting information at a slightly higher level for more accessible discussion. Visual Cues for Workflow Understanding: Traffic Light System:</p>	<p>The respondent highlighted the importance of effectively conveying expertise among Subject Matter Experts (SMEs) and the value of data in improving processes. Key points included understanding billing cycles, cash collection, and using AI to manage tasks efficiently. Regularly reviewing forecasting assumptions, using heat maps to identify improvement areas, and utilizing KPIs were emphasized. The respondent also stressed the importance of change management and training. Finally, the vision for data visualization was presented as a crucial user interface tool for the future.</p>

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
		<p>and highlight important information for stakeholders. Verification aid: Visualizations help verify data and spot outliers or issues. Process support: While less emphasized, visualizations can help identify process bottlenecks. Client enablement: The focus is on transitioning knowledge to clients so they can create their visualizations in the future. Consistency: Their team maintains a consistent style and theme across developers. Overall, the respondent views visualization as crucial for effective communication and data verification, emphasizing simplicity and stakeholder understanding.</p>	<p>Accessibility: There's a growing expectation for visualizations to be available on mobile devices, not just in office settings. Simplicity for Certain Audiences: For some audiences, like lawyers, the respondent suggests that visualizations must be straightforward, almost like a simple gauge indicating good or bad. Progressive Implementation: The respondent believes that gradually introducing visualizations can be compelling. Users who become comfortable with basic visualizations often request more complex ones. Future Trend: The respondent sees visualization as a growing trend, with people likely to ask for more as they become accustomed to visually seeing data. While the respondent's current</p>	<p>The respondent uses a standard traffic light system (green, amber, red) to indicate the status of tasks and drive conversations about issues. Lack of Consistent Visual Standards: No consistent use of colours or symbols across the program, highlighting a need for standardized visual cues. Communication with Developers vs. Business Side: Technical Communication: Relies on verbose descriptions in Word documents and detailed technical documents for developers. Business Communication: Uses visualizations to demonstrate how systems work to business stakeholders. Coding Workflow and Assumptions: Business Process Documents:</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			<p>use of visualizations seems limited, she recognizes their increasing importance and the potential for greater incorporation in their processes in the future.</p>	<p>Creates detailed documents using the swim lane methodology to articulate business processes.</p> <p>Uses text-based descriptions for business requirements and technical aspects.</p> <p>Systems for Communication and Configuration: Limited Specific System Mention: The respondent does not mention specific systems used for communication and configuration in the given context.</p> <p>Use of Visualizations: Business Demonstrations: Use visualizations to demonstrate systems to business stakeholders.</p> <p>Executive Communication: Utilizes heat maps for discussions with the executive team.</p> <p>Improvement Potential: Acknowledges the need to improve the use of visualizations in communicating with</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
				<p>developers and system experts.</p> <p>Billing Workflow:</p> <p>Text-Based Descriptions: It likely relies on text documents to describe billing workflows, especially for the technical team.</p> <p>Workshops and Meetings:</p> <p>Facilitation by SMEs: Technical or business owner SMEs, often application consultants, facilitate workshops to discuss and agree on configurations and calculations.</p> <p>Decision-Making Process:</p> <p>SME Agreements: Application consultants suggest metrics derivations and business owners agree or disagree with them based on current business practices.</p> <p>Regional Variations: Calculations can be regionally driven, with different regions potentially calculating metrics like lock-up days differently.</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
				<p>Documentation: Decision Records: Decisions are documented and circulated through meeting minutes or workshop outputs. Emphasis on Written Records: The respondent relies on text-based documentation to ensure consistent understanding, with limited use of visual aids in this context. Future of Visualizations: AI Integration: The respondent sees potential for AI to enhance visualizations but emphasizes the importance of dynamic information presentation. Voice Interaction: Suggests future developments, including voice interaction, for ease of use. Simplification and Ease of Understanding:</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
				<p>Stresses the need to present complex information simply and accessibly, using dynamic and user-friendly visualizations.</p> <p>Challenges in Implementation:</p> <p>Acknowledges the difficulty of implementing advanced visualization technologies effectively.</p> <p>Overall Implications:</p> <p>Visualizations are crucial in effective communication, especially for complex processes and broad concepts.</p> <p>There is significant potential to enhance visualization use in technical communication and improve understanding of budgeting and forecasting cycles.</p> <p>Standardization and better integration of visual tools could address current inconsistencies and improve clarity in conveying information across different stakeholders.</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
1	How many years have you worked implementing systems in the legal industry?	30+	30+	15+	20+
2	How do you convey and adapt what you base your subject matter expert decisions on to other SMEs within your region? Please also elaborate on using visual clues to convey this knowledge when conveying workflow understanding.	<p>Simplicity: They emphasize keeping visualizations as simple as possible, avoiding complex visualizations that might confuse stakeholders who are not as familiar with the data. Purpose-driven: They focus on why something should be put on screen rather than just displaying information because they can. Their approach is to ask, "Why should we put something on the screen?" Gradual complexity: They start with very simplistic visualizations and then "breadcrumb" into more detail if the user consumes more data.</p> <p>Audience-focused: They organize a framework for discussion based on who the audience is and what they need. This helps in creating a</p>	<p>Initially, the respondents mentioned using a few visualizations in this phase to convey knowledge to other SMEs or developers. However, when it comes to conveying information to clients at the start of a project, they do use visualizations: - They have slides that they can share to break down the project. - These slides show what they're doing at each project stage. For specific workflows like billing, they use: - A workflow diagram showing different steps. - This diagram is transformed into a more visually appealing PowerPoint slide that "looks nicer than video diagrams" but contains the same data. For internal</p>	<p>According to the respondent's response, he uses the following approaches to convey subject matter expert decisions to other SMEs within his region: He uses a simplistic high-level plan of the program, often split by week, showing from the current point to the end. He sometimes focuses on specific areas, like the development cycle, going into more detail. He frequently uses Excel-based visualizations because they're easy to manipulate, even though they're underpinned by a fully developed program plan that's hundreds of lines long. He prefers to present information at a slightly</p>	<p>Enhancing SME Collaboration and Process Improvement</p> <p>The respondent discussed the importance of effectively conveying subject matter expertise to other Subject Matter Experts (SMEs). The respondent shared her experience and highlighted the value of data in improving processes and understanding fail points. The respondent emphasized the significance of understanding billing cycles, cash collection, and forecasting new heads. They also touched on the importance of reducing the number of days from wip to billing to expedite cash collection.</p>

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
		<p>matrix of requirements for each audience. Effective use of heat maps: They find heat maps particularly effective because they usually look at 2 or 3 data points, avoiding information overload.6.</p> <p>Standard visualizations: They lean towards using standard, simple visualizations like bar charts or stack bar charts that allow the point to speak for itself rather than creating custom visualizations. The respondent's approach prioritizes clear communication and stakeholder understanding over complex or innovative visualization techniques.</p>	<p>communication with developers, the process is less visual: - They might use Excel to list the stages. - Communication is more verbal and text-based rather than picture-driven. For decision trees or system logic: - The billing workflow has a picture that shows decision points (e.g., "Does it need approval? Yes or no"). - It includes a flow-through with decision trees to explain why specific actions are triggered. In summary, while they don't heavily rely on visualizations for internal SME communication, they use visual aids like slides, workflow diagrams, and decision trees, especially when conveying information to clients or explaining complex workflows.</p>	<p>higher level for more accessible discussion. Regarding visual clues to convey workflow understanding: The respondent mentions no consistent use of colours or symbols across the program he's currently working on, nor has there been much consistency historically. However, he uses a standard traffic light system: - Green to indicate something is on track - Amber, if it's slightly off-track - Red if it's going off track. He notes that using these colours helps drive conversations about why something might be red and what that means. The respondents also mentioned that for more technical aspects, like conveying information to developers, they rely less on visualizations and more on verbose descriptions in Word documents. However, they use visualizations more</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
				frequently when demonstrating how something will work on the business side.	
3	<p>What kinds of information do you provide to the system experts to code the workflow and assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would</p>	<p>Visualization for requirements: From the requirements matrix, they work backward to determine appropriate visualizations. Pre-canned solutions: They start with out-of-the-box solutions and then customize them based on client feedback. Eliciting requirements: Their process is more about eliciting requirements than defining workflows. Simplicity in visualization: They prefer simple, standard visualizations like bar charts or stack bar charts over complex custom visualizations. Workflow understanding: While they don't mention visual clues for conveying workflow understanding, they mention visualizations to highlight processes' bottlenecks. For</p>	<p>Billing Workflow: - They use a workflow diagram that shows different steps. - This diagram is transformed into a more visually appealing PowerPoint slide that looks nicer than traditional diagrams but contains the same data. Internal Communication: - For internal work with developers, they often use Excel to list stages. - The communication is more verbal and text-based rather than picture-driven. Decision Trees: - The billing workflow includes a picture that shows decision points. - It has a flow-through with decision trees to explain why specific actions are triggered. - For example, it</p>	<p>For coding workflow and assumptions: - They create detailed business process documents that articulate business processes using traditional swim lane methodology. - When communicating with developers, they typically use verbose descriptions in Word documents to describe business requirements. - They use detailed, primarily text-based technical documents for more technical aspects. Systems used for communication and configuration: - The respondents don't mention specific systems for this purpose in the given context. 3. Use of visualizations: - The respondents admit they could better use</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
	occur in your region.	example, they might create reports that show if a particular step in a process consistently takes longer than expected.	might show "Does it need approval? Yes or no" or "Was the write-off more than a certain percentage? Yes - it's going to kick off this workflow." Heat Maps: - The respondent mentions that her team uses heat maps internally to drill down on data. - However, these heat maps are not typically used with clients. Workflow States: - There's mention of a workflow that shows different stages and decision points. - This includes visual representations of whether edits need approvals (yes/no) and other decision points. Systems for Communication: - While not explicitly mentioned, they use standard tools like Excel and PowerPoint for communication and configuration. Overall, while they use some visualizations, especially for client-facing materials	visualization when communicating with developers or system experts to code workflows and assumptions. - However, visualizations are used when demonstrating how something will work for the business. - As a program manager, the respondent uses heat maps when talking with his executive team but rarely uses them to hand off work to the technical team for development.4. Regarding a stepped process for billing workflow: - The context doesn't provide a specific example of how the billing workflow would be visualized in the respondents' region. - However, based on his comments, it's likely that such a workflow would be primarily described in text documents rather than visualized, especially when communicating with the technical team.The	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			and complex workflows, the internal process of providing information to system experts relies more on verbal and text-based communication, using Excel and basic diagrams.	respondents acknowledge that they could improve their use of visualizations in this area of work, suggesting that there's potential for better integration of visual tools in their workflow communication and configuration processes.	
4	How is the information that you provided to configure the system and drive the calculations agreed upon by SMEs? Are there forums or workshops to facilitate this? Please also elaborate on the use of Visualizations to concur with this knowledge.	Heat maps: These are mentioned as particularly effective tools, especially for displaying 2-3 data points. This could be a visual tool that individuals continue to use in future implementations.6. Standard charts: Bar charts and stack bar charts are preferred for their simplicity and effectiveness in conveying information.	Workshops: - There are workshops to help you agree on design decisions. - the respondent mentions something called a "DDF" (though she's unsure what the "F" stands for), which seems to be a type of workshop or decision-making forum. Visualization in Workshops: - The primary form of visualization in these workshops is demonstrating the software. - They show "what it could do" and "the impact of it." - The visualization is often the software rather than	Workshops or meetings: - These are generally facilitated by the technical or business owner subject matter expert, often application consultants. - They work with business subject matter experts to discuss and agree on configurations and calculations. Decision-making process: - Application consultants suggest how metrics should be derived. - Business owners then agree or disagree with these suggestions. - They often work within the parameters of current	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			<p>separate visual aids.</p> <p>Agreement Process: -</p> <p>These workshops are the main forum for SMEs to agree on system configuration and calculations. Limited Use of Other Visualizations: -</p> <p>The respondent mentioned that a few slides might be used, but she was unsure.</p> <p>- She notes that they should use more visualizations, suggesting limited current use. Current Practices: - Instead of extensive separate visualizations, they mainly use the software as the visual aid. - Large spreadsheets are given to fill in codes, but these could be more visual.</p> <p>Room for Improvement: -</p> <p>The respondent suggests they could benefit from using more visualizations in this process, indicating that the current approach might not be optimal. In summary,</p>	<p>business practices.</p> <p>Regional variations:</p> <p>- Some calculations are regionally driven, while others are more global.</p> <p>- The respondent mentioned that in his current program, which spans multiple regions, each region might calculate specific metrics (like lock-up days) differently.</p> <p>Agreement and documentation:</p> <p>- Decisions are recorded and circulated to ensure everyone understands and agrees.</p> <p>- This is typically done through meeting minutes or workshop outputs rather than visualizations.</p> <p>Regarding the use of visualizations in this process:</p> <p>The respondents don't mention the specific use of visualizations for agreeing on configurations or calculations.</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			<p>while there are workshops to facilitate agreement among SMEs, the use of visualizations in this process seems limited. The primary visual aid is the software itself, with some potential use of slides. The respondent's response suggests room for improvement in using more dedicated visualizations to aid the agreement process.</p>	<p>He emphasizes recording decisions in "black and white" to avoid misunderstandings. However, the respondents do acknowledge the value of visualizations in general: He believes visualizations are crucial for effective communication and verification of decisions. Visualizations are seen as more accessible for people to understand and consume, especially for large quantities of information. They're handy for presenting program risks, schedules, and delivery management concepts. In summary, while forums and workshops facilitate agreement on system configurations and calculations, visualizations are not heavily utilized in this part of the process in the respondents' current work environment.</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
5	How do you, as an individual, make the new knowledge your own and apply this within the next budgeting and forecasting cycle? What visual cues or tools assist the process?	<p>Developer preferences: The respondent notes that their developers gravitate towards certain styles and themes that are consistent across the team. This suggests that individuals internalize effective visualization techniques over time.</p> <p>2. Lack of formal process: There needs to be a recognized process at the end of projects to evaluate the effectiveness of visualizations or refine them for future use. Knowledge transition: The focus is more on enabling the client firm to create visualizations in the future rather than refining the team's knowledge base.</p> <p>Simplicity in visualization: The team consistently emphasizes keeping visualizations simple and easy to understand, which could be a fundamental principle applied in future cycles.</p> <p>5.</p>	<p>Knowledge Transfer Forums:</p> <ul style="list-style-type: none"> - There are two main forums for knowledge transfer: <ul style="list-style-type: none"> a. Admin staff passing information to client staff b. Client staff giving information back to Admin (in later stages) <p>Cycle of Knowledge Exchange:</p> <ul style="list-style-type: none"> - Initially, the admin team drives the process and guides the client. - As they reach the final stages, the process is reversed, with clients providing feedback to the admin team. - This allows the admin team to identify gaps or issues in the setup. <p>Use of Software as Visualization:</p> <ul style="list-style-type: none"> - The respondent mentions that they mainly use the software to visualize. - There's limited use of 	<p>Documentation:</p> <ul style="list-style-type: none"> - The respondents emphasize the importance of recording decisions when they are made. - This is typically done through minutes of meetings or outputs from workshops. - These records are then circulated to ensure everyone has a clear understanding. <p>Limited use of visualizations:</p> <ul style="list-style-type: none"> - The respondents explicitly state that visualization must be used more in this process. - He relies more on written documentation to capture and share knowledge. <p>Emphasis on clear communication:</p> <ul style="list-style-type: none"> - The respondents recognize that communication can be received differently by different individuals. - He uses written records to ensure everyone has the same understanding of 	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			<p>dedicated visual aids or slides in this process.</p> <p>Limited Use of Other Visualizations:</p> <ul style="list-style-type: none"> - The respondent notes that there are a few slides she's seen, but they use only a few. - She suggests that they should use more visualizations. <p>Current Tools:</p> <ul style="list-style-type: none"> - Large spreadsheets are used to input codes and information. - However, these spreadsheets need more visualization elements. <p>Room for Improvement:</p> <ul style="list-style-type: none"> - The respondent acknowledges the potential to incorporate more visualizations in this process. <p>Internalizing and applying new knowledge relies heavily on interactive forums and software rather than dedicated visual tools. At the same time, some</p>	<p>decisions and agreements.</p> <p>Visual cues or tools:</p> <ul style="list-style-type: none"> - The context does not mention any specific visual cues or tools the respondent uses to assist in this process. - He seems to rely more on text-based documentation rather than visual aids for this aspect of knowledge management and application. <p>In summary, the respondents' approach to internalizing and applying new knowledge for budgeting and forecasting cycles appears to be primarily text-based, with little emphasis on visual tools. He prioritizes clear, written documentation and circulation of this information to ensure consistent understanding across team members. The lack of visual aids in this process could be an area for improvement, given the respondents'</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			<p>slides and spreadsheets are used. The respondent suggests that the process could benefit from more visual aids. The current approach focuses more on practical application through the software rather than separate visual cues or tools.</p>	<p>acknowledgment of the general value of visualizations in communication elsewhere in the interview.</p> <p>Based on the respondent's responses, here are the key points about the future of visualizations:</p> <p>AI Integration:</p> <ul style="list-style-type: none"> - The respondent acknowledges that AI is an obvious route for the future of visualizations, though he considers other aspects more important. <p>Dynamic Information Presentation:</p> <ul style="list-style-type: none"> - The respondents emphasize the importance of dynamic information presentation. - He mentions current work using Power BI to create visualizations allowing different filters and views of the same data set. <p>Voice Interaction:</p> <ul style="list-style-type: none"> - The respondents suggest that being able to talk to the 	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
				computer to explain what is wanted, rather than typing it in, could be a future development.	
6	Does visualization assist with communication, process, or verification?	<p>The respondent's approach to using visualizations in their projects aims to keep their visualizations as simple as possible to ensure stakeholders can easily understand them. They also use visualizations to elicit client requirements rather than dictate workflows. Additionally, they encouraged internal stakeholders to use visualizations to improve communication and verification and to ensure that the knowledge gained from projects is readily accessible to the business.</p> <p>They start with simple visualizations and only add complexity if necessary, avoiding "kitchen sink" approaches that overwhelm stakeholders. They use visualizations to tell</p>	<p>Sales Process vs. Implementation: Some visualizations are used in the sales process but don't carry over into the actual project implementation. The respondent states, "We do some in the sales process, but I don't think they follow those two into the actual. Project." Focus on Product Demonstration: Instead of visualizations, they focus on walking clients through the product. The respondent mentions, "I think a lot of it's based on. Let me walk you through using it. Product rather than having a visualization." Potential for Improvement: The respondent acknowledges that they could use more visualizations in the</p>	<p>Visualization assists with communication, process, and verification based on the respondents' responses. Here are the key points he made:</p> <p>Crucial for effective communication:</p> <ul style="list-style-type: none"> - The respondents believe visualizations are "crucial" and "critical" for effective communication. - They help ensure everyone understands and agrees upon decisions. <p>Adaptability to different scenarios:</p> <ul style="list-style-type: none"> - Visualizations can be used for specific decisions (e.g., updating metrics) and broad concepts (e.g., program risks, schedules, delivery management). - The type of visualization used depends on the 	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
		<p>a story and highlight important information for different levels of stakeholders.</p> <p>They prefer standard, simple visualizations like stack bar charts over complex or custom visualizations. Heat maps are used effectively as they typically focus on 2-3 data points and allow for drill-down capabilities.</p> <p>The respondent's team encourages co-resourcing and knowledge transfer to enable clients to create visualizations in the future.</p> <p>Their projects primarily use visualizations for communication and verification purposes.</p> <p>Communication: The respondent strongly emphasizes that visualization is vital for communication. They state that visualizations "tell the story" And are used for "highlighting information for stakeholders at different levels of the business."</p>	<p>implementation process. She notes that someone on her team is very visual, which has led to better visualizations in the sales process, suggesting there's potential for more use in implementations. Lack of Specific Examples: The respondents must provide concrete examples of visualizations used for communication, process, or verification in their current implementation practices. In summary, while visualizations have some role in the sales process, they appear less utilized for communication, process, or verification during actual implementations.</p>	<p>audience and the question.</p> <p>Ease of understanding:</p> <ul style="list-style-type: none"> - The respondents prefer visualizations because they are more accessible for people to understand and consume. - They help present large quantities of information in a more digestible format. <p>Consistency in communication:</p> <ul style="list-style-type: none"> - Visualizations provide a consistent way of presenting information, unlike "many words on a bit of paper." <p>Verification:</p> <ul style="list-style-type: none"> - While not explicitly stated, the emphasis on ensuring decisions are "well understood and agreed by everybody" suggests that visualizations aid in the verification process. <p>Process improvement:</p> <ul style="list-style-type: none"> - The respondents imply that visualizations can improve processes by making information more accessible and 	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
		<p>Visualizations help convey what information stakeholders should be interested in.</p> <p>Verification: The respondent also confirms that visualization aids in verification. They mention two specific examples:</p> <ul style="list-style-type: none"> - Event-driven reports that highlight issues like outstanding invoices from a year ago. - Charts that make it easy to spot outliers, such as in accounts receivable by department. <p>Process: While the respondent considers this category more ambiguous, they mention that visualization can support efficient processes. For example, they sometimes create reports highlighting process bottlenecks, such as identifying steps that consistently take longer than expected. The respondent concludes that visualization assists with communication and verification, while its role</p>		<p>understandable to all stakeholders.</p> <p>In summary, the respondents strongly believe that visualizations are valuable tools that assist in communication, can improve processes, and help with verification by ensuring consistent understanding across team members. He sees them as preferable to text-heavy communication in many scenarios.</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
		in process support could overlap with the other two categories.			
	What do you see in the future for visualization?	<p>AI-generated commentary: The respondent finds AI interpreting numbers and providing commentary on visualizations interesting. They believe this will become more common in the future. Personalized insights: The respondent sees potential in refining AI-generated commentary to be more accurate and tailored for individual firms. Timeframe uncertainty: While they believe these advancements are coming, they're unsure if it will be "a year away or ten years away." Current limited use: The respondent's firm uses AI sparingly for visualizations or forecasting. Overall, the respondent sees AI as a promising tool for enhancing visualizations and data interpretation in the future. Still, their current use</p>	<p>Increasing Demand: The respondent sees "quite a lot coming" regarding visualization. She believes people are expecting much more visual representation of data now. Tools like Power BI: She mentions that using tools like Power BI and similar technologies is becoming more prevalent. Shift from Traditional Reports: The respondent notes a move away from traditional reports with "loads of numbers" towards more visual representations. Mobile Accessibility: She emphasizes the importance of mobile access to visualizations. The respondent expects people to be able to view visualizations on their phones or tablets, not just</p>	<p>Based on the respondent's responses, here are the key points about the future of visualizations: AI Integration: - The respondent acknowledges that AI is an obvious route for the future of visualizations, though he considers other aspects more important. Dynamic Information Presentation: - The respondents emphasize the importance of dynamic information presentation. - He mentions current work using Power BI to create visualizations allowing different filters and views of the same data set. Voice Interaction: - The respondents suggest that being able to talk to the computer to explain what is</p>	<p>The respondent proposed using AI to manage daily tasks and bills, suggesting that this could improve efficiency and reduce the workload of legal professionals. She also highlighted the importance of regularly reviewing and revisiting forecasting assumptions to ensure accuracy.</p>

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
		of AI in this context needs to be improved.	<p>in the office. Progressive Adoption: The respondent believes that as people get used to basic visualizations, they will ask for more complex ones. She sees this as a gradual process of adoption and increased sophistication. Potential for Growth: She suggests that people may have yet to learn what visualizations could benefit them. However, as they start seeing them "in a small way," the demand and utility will grow. Industry Adaptation: The respondent implies that the legal industry, traditionally less visual in its data presentation, will likely move towards more visual representations of information. Overall, the respondent believes that visualization is a growing trend in the industry, with increasing expectations for more visual, accessible,</p>	<p>wanted, rather than typing it in, could be a future development.</p> <ul style="list-style-type: none"> - However, he sees this as a "nice to have" rather than a critical feature. <p>Focus on Ease of Understanding:</p> <ul style="list-style-type: none"> - The respondents stress the importance of presenting information in a way everyone can understand. - He notes that sometimes current visualizations are well understood by those who requested them but may need to be simplified for end-users. <p>Simplification of Complex Data:</p> <ul style="list-style-type: none"> - There's a need to present complex information using widely understood terminology. <p>Challenges in Implementation: - The respondent notes that while these advancements are possible, implementing them effectively remains</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			and sophisticated ways of presenting data across various platforms.	challenging. Overall, the respondents see the future of visualization as moving towards more dynamic, interactive, and user-friendly presentations of data, with a focus on making complex information accessible to all users, potentially aided by AI and voice interaction technologies.	
	Do you think about the proposed budgeting and forecasting system automation using visualization as feedback?	Potential in forecasting: While they don't currently use AI, the respondent acknowledges its potential in this area, particularly in analyzing historical data to project future trends. Interactive reports: They envision that "reports will talk to you in the future." Users might log into a screen and receive both visual data and AI-generated commentary, either written or spoken. Use of heat maps: They use heat maps for adequate visualization, particularly when looking at 2 or 3 data points.	Based on the context, the respondent's thoughts on using visualizations to refine budgeting, forecasting, or other systems as feedback could have been more varied and cautious. Here are the key points from her response: 1. Heat maps: The respondent found using heat maps for P&L (Profit and Loss) and budget interesting, but she expressed concern about whether people generally understand heat map visualizations. Simplicity	Difficulty of concept: The respondents acknowledge that forecasting and budgeting are complex concepts for people to understand comprehensively, especially when considering the whole firm's perspective. Value of heat maps: He believes using a heat map to drive budget understanding (showing what's on track or off track) is a much easier way for people to grasp the information. Lack of out-of-the-box solutions: The respondents	The respondent explained that she uses heat maps to identify areas needing improvement and that KPIs can be a powerful tool when understood and agreed upon by the team. They also discussed the importance of change management and training to ensure everyone is on the same page and understands the data. Lastly, the respondent expressed her vision for the future of data visualization, emphasizing its importance as a primary interface for users.

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			<p>for lawyers: She emphasized that for lawyers looking at figures, the visualization needs to be very straightforward, "almost a gauge to say good or bad." She must determine whether lawyers are used to seeing nuances between good and evil.</p> <p>Progressive adoption: The respondent suggested that the use of visualizations could grow over time. She mentioned that when they roll out dashboard tiles, they advise firms to start with a few simple tiles showing primary data. As users become comfortable, they often request more information.</p> <p>Growth potential: She believes that as people get used to visualizations, they will likely ask for more. The respondent stated, "You probably don't know what they are. Could benefit from until they start seeing</p>	<p>haven't seen technology that comes "out of the box" to implement this system quickly.</p> <p>Current approach: In his experience, they typically use data from the budgeting tool and transform it into more easily consumable information.</p> <p>Reporting layer: He sees this kind of visualization more as a reporting layer on top of the budgeting tool rather than an integrated part of the tool itself.</p> <p>Potential: While not directly endorsing the proposed system, the respondents' comments suggest he sees value in using visualizations like heat maps to make budgeting and forecasting information more accessible and understandable.</p> <p>Industry maturity: He notes that the legal industry could be more mature in how it uses technology and data,</p>	

No	Question	Response Participant 1 MT	Response Participant 2 KB	Response Participant 3 MB	Response Participant SD
			it in a small way, and then it will grow." Current practices: The respondent mentioned that her team uses some heat maps internally, but these aren't typically used with clients.	implying there's room for improvement in this area. Overall, while the respondents don't explicitly endorse the proposed system, his comments suggest he sees potential value in using visualizations to improve understanding and use of budgeting and forecasting data in the legal industry.	

Table 17: Common Themes SMEs Compared to SEs (Detail)

Question	Common Themes SMEs	Common Themes SEs
Summary	<p>Visualization aids in understanding workflows, particularly in data conversion and testing. Highlights areas where data passes or fails during the conversion process.</p> <p>Training and Communication: Visual aids are essential for training SMEs to understand new processes and data. Provides system experts with detailed information about the data conversion process, necessary reports, and critical areas for checking.</p> <p>Implementation and Testing: Visualization tools like data mapping and logging are vital for identifying issues and areas for refinement. Visual cues, such as maps of data conversion, aid in process verification and communication. Use of Visual Aids: Various visual aids such as Microsoft</p>	<p>Simplicity is Key: Emphasizes keeping visualizations simple to ensure stakeholders easily understand them.</p> <p>Purpose-Driven Visualizations: It focuses on why something should be visualized rather than just putting information on screen because it's possible.</p> <p>Audience-Centric: Tailors' visualizations to different stakeholder needs and levels within the business.</p> <p>Standardization and Practical Tools: Standard Over Custom: He prefers using standard, simple visualizations like stack bar charts over custom, complex visualizations.</p> <p>Practical Tools: Uses heat maps to display 2-3 data points with drill-down capabilities.</p> <p>Traffic Light System:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Visio, flowcharts, diagrams, and PowerPoint presentations are used. Visual tools explain complex processes like billing workflows and ensure consistent understanding among regional SMEs.</p> <p>Consistency and Standardization: Visual tools are used consistently across projects for clarity. Lack of standardized notations for daily processes, making visual aids essential for communication.</p> <p>Workshops and Demonstrations: Conducts in-person and remote workshops to present findings and gather user feedback. Demonstration environments help users visualize potential solutions.</p> <p>Feedback and Adjustments: Post-implementation feedback is collected and used for adjustments. Information is presented during project closure meetings using visual tools like PowerPoint and Excel.</p> <p>Reporting and Colour Coding: Uses reporting tools with dashboards that include colour-coded tiles to represent different information visually.</p> <p>Crucial Role of Visualization in Communication: Visualization is essential for effective communication, especially complex processes or concepts. Visual aids are considered a must in day-to-day work, emphasizing the necessity of visual cues in presentations and workshops.</p> <p>Methods of Conveying Expertise: Uses process diagrams, flowcharts, reporting examples, and standard profit and loss heat maps. Emphasizes simplicity and clarity using tools like PowerPoint and process flow diagrams.</p> <p>Information for System Experts: Provides detailed information on business drivers, key milestones, and decision rationales. Uses reporting examples and visualizations for effective communication. Employs dashboards and interactive tools for precise information delivery.</p> <p>Structured Meetings and Reviews: Holds structured meetings and reviews for alignment on configuration and communication. Uses visualizations to verify information accuracy and highlight areas needing attention.</p>	<p>A standard traffic light system (green, amber, red) indicates task status and drives conversations about issues.</p> <p>Communication and Verification:</p> <p>Communication Tool: Visualizations are primarily used to tell a story and highlight important information for stakeholders.</p> <p>Verification Aid: It helps verify data and spot outliers or issues.</p> <p>Process Support: It can help identify process bottlenecks, though this needs to be more emphasized.</p> <p>Client Enablement and Consistency: Client Enablement: Focuses on transitioning knowledge to clients so they can create their visualizations in the future.</p> <p>Consistency: Maintains a consistent style and theme across developers.</p> <p>Current Use and Future Potential: Limited Current Use: Acknowledges limited use of visualizations in implementation processes, relying more on walking clients through software.</p> <p>More Prevalent in Sales: Visualizations are used more in the sales process, but these don't typically carry over into project implementation.</p> <p>Room for Improvement: Recognizes the need for more visualizations in their processes.</p> <p>Evolving Expectations: Notes that clients increasingly expect more visual representations of data, especially with tools like Power BI becoming common.</p> <p>Mobile Accessibility: There is a growing expectation for visualizations to be available on mobile devices.</p> <p>Simplification and Progressive Implementation: Simplicity for Certain Audiences: Visualizations must be straightforward for audiences like lawyers, using simple gauges to indicate performance.</p> <p>Progressive Implementation: Believes in gradually introducing visualizations, with users often requesting more complex ones as they become comfortable with basics.</p> <p>Future Trends and Challenges: Growing Trend: Sees visualization as a growing trend with increasing requests as users become accustomed to visually seeing data.</p> <p>AI Integration:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Workshops and Cultural Buy-In: Facilitates workshops to discuss and agree on critical processes and gain cultural buy-in. Uses visualizations to help SMEs understand output reporting and key drivers.</p> <p>Simplicity and Focus: Keep processes simple and focused on business variables for effective implementation. Visual tools like waterfalls and heat maps track variances and inform budgeting and forecasting cycles.</p> <p>Future Applications: Suggests fine-tuning processes based on previous cycles' experiences and learnings. Potential use of automation and AI for data analysis and trend identification.</p> <p>Effectiveness of Visualization: Visualization aids in communication, process understanding, and verification. Helps in self-service understanding, immediate issue identification, and maintaining structured meetings and reviews. Breaking Down Requirements: Uses charts to break down requirements into must-haves, nice-to-haves, and middle-of-the-road features. Employs mind maps to identify possibilities within a process flow. It uses heat maps to highlight unexpected values and considers colour values for visualizations to cater to individuals with colour blindness. Simple presentations and visualizations using tools like Excel are often the most effective.</p> <p>Implementation Process: Uses visualizations to document standard workflows, track budgets, and actuals, and identify variances. Visualizations document lessons learned from each project to improve methodology and delivery. Visual aids improve communication and process understanding. General Perspective: Visualization is an assertive communication, process, and verification tool. Effective in helping people understand complex systems and data flows. While valuable for communication and process, its role in verification is seen as less critical.</p> <p>Use in Large Data Sets: Visualization is beneficial when dealing with large volumes of data or complex calculations, making it easier to comprehend and analyze.</p>	<p>It acknowledges the potential for AI to enhance visualizations but emphasizes dynamic information presentation.</p> <p>Voice Interaction: Suggests future developments could include voice interaction for ease of use, though it's seen as a "nice to have."</p> <p>Simplification of Complex Data: Stresses the need to present complex information and accessibly.</p> <p>Implementation Challenges: Recognizes the difficulty of effectively implementing advanced visualization technologies.</p> <p>Overall Implications: Visualizations are crucial for effective communication, data verification, and supporting processes. Emphasizing simplicity, standardization, and audience-centric approaches can enhance understanding and enable better decision-making. There is significant potential to improve the use of visualizations in technical communication and project implementation, with evolving client expectations driving the need for more dynamic, accessible, and user-friendly visual tools.</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Late Integration Issue: One participant noted that visualizations are often built later in the project, which could imply a need for earlier integration in the project lifecycle.</p>	
<p>How many years have you worked implementing systems in the legal industry?</p>		
<p>How do you convey and adapt what you base your subject matter expert decisions on to other SMEs within your region? Please also elaborate on using visual clues to convey this knowledge when conveying workflow understanding.</p>	<p>Conveying Workflow Understanding: Data Conversion and Testing: Visualization helps convey workflow understanding, particularly in data conversion and testing. Process Visualization: Flowcharts, waterfalls, dashboards, and swim lanes visually represent the process flow and areas of responsibility. Training and Communication: Essential for SME Training: Visual aids are crucial for training SMEs to understand new processes and data. Demonstration Environments: These show how things would work out of the box, helping SMEs visualize potential solutions. Implementation and Testing: Issue Identification: Visualization tools like data mapping and logging are vital for identifying issues and areas for refinement. Verification and Communication: Visual cues, such as maps of data conversion, aid in process verification and communication. Use of Visual Aids: Variety of Tools: Visual aids such as Microsoft Visio, flowcharts, diagrams, PowerPoint presentations, heat maps, mind maps, and Excel are used. Visual Cues and Symbols: Uses symbols, colours, and icons to highlight important information and represent different steps in the process. Consistency and Standardization: Consistent Use Across Projects: Visual tools are used consistently across projects for clarity. Standardized Visuals: Programs often need a standardized set of visuals, such as high-level architecture diagrams and data flow visualizations. Workshops and Demonstrations:</p>	<p>Simplicity: Emphasizes keeping visualizations simple to avoid confusing stakeholders unfamiliar with the data. Utilizes standard visualizations like bar charts or stack bar charts to allow the data to speak for itself. Purpose-Driven: Focuses on the reason for displaying information, ensuring every visualization has a clear purpose. Ask, "Why should we put something on the screen?" to drive visualization choices. Gradual Complexity: It starts with simple visualizations and gradually introduces more detail as users become comfortable with the data. It uses a "breadcrumb" approach to lead users from basic to more complex information. Audience-Focused: Organizes discussions and visualizations based on the audience's needs and requirements. Create a requirements matrix tailored to different stakeholder groups to ensure effective communication. Effective Use of Heat Maps: Finds heat maps particularly effective for displaying 2-3 data points, avoiding information overload. Standard Visualizations: Prefers standard, simple visualizations over custom, complex ones to maintain clarity and ease of understanding. Visual Cues and Tools for Workflow Understanding: Use of Slides for Clients: Uses slides to break down the project stages and convey information to clients at the project's start. Transforms workflow diagrams into visually appealing PowerPoint slides for client presentations. Workflow Diagrams and Decision Trees: Uses workflow diagrams to show different steps in processes like billing. Employs decision trees to illustrate decision points and explain the logic behind specific actions. Internal Communication with Developers:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Collaborative Workshops: Conducts in-person and remote workshops to present findings, gather user feedback, and discuss best practices.</p> <p>Visual Feedback: Uses visualizations in workshops to aid understanding and agreement on system configurations and processes.</p> <p>Feedback and Adjustments:</p> <p>Post-Implementation Feedback: Collects and uses feedback for adjustments post-implementation.</p> <p>Presentation of Adjustments: Information is presented during project closure meetings using visual tools like PowerPoint and Excel.</p> <p>Reporting and Colour Coding:</p> <p>Dashboards with Colour-Coded Tiles: Dashboards with colour-coded tiles represent different information and visually highlight variances.</p> <p>Crucial Role of Visualization:</p> <p>Essential for Communication: Visualization is essential for effective communication, especially complex processes or concepts.</p> <p>Daily Necessity: Visual aids are considered a must in daily work, emphasizing the need for visual cues in presentations and workshops.</p> <p>Methods of Conveying Expertise: Process Diagrams and Flowcharts: Process diagrams, flowcharts, and standard profit and loss heat maps convey expertise. - Simplicity and Clarity: Emphasizes keeping information simple and easy to understand using tools like PowerPoint and process flow diagrams.</p> <p>Information for System Experts: - Detailed Information: Provides detailed information on business drivers, key milestones, and decision rationales using reporting examples and visualizations. - Clear Communication: Uses dashboards and interactive tools for precise information delivery.</p> <p>Structured Meetings and Reviews: - Alignment on Configuration: Holds structured meetings and reviews to ensure alignment on configuration and communication. - Accuracy Verification: Uses visualizations to verify information accuracy and highlight areas needing attention.</p>	<p>Relies less on visualizations for internal communication, preferring verbal and text-based methods.</p> <p>Use Excel to list stages and provide detailed descriptions to convey information to developers.</p> <p>The respondent's Specific Approaches:</p> <p>Simplistic High-Level Plans:</p> <p>Utilizes high-level program plans, often split by week, to show the timeline from the current point to the end.</p> <p>Detailed Focus Areas:</p> <p>Sometimes, it provides more detailed views on specific areas like the development cycle.</p> <p>Excel-Based Visualizations:</p> <p>It frequently uses Excel for visualizations due to its ease of manipulation, supported by a comprehensive program plan.</p> <p>Higher-Level Information Presentation:</p> <p>Prefers presenting information at a slightly higher level to facilitate more accessible discussion.</p> <p>Traffic Light System:</p> <p>Uses a traffic light system (green, amber, red) to indicate the status of tasks and drive conversations about issues.</p> <p>Lack of Consistent Visual Standards:</p> <p>Acknowledges the lack of consistent use of colours or symbols across the program, highlighting the need for standardized visual cues.</p> <p>Summary:</p> <p>Approach Priorities: Emphasizes simplicity, purpose-driven visualizations, gradual complexity, and audience focus to ensure clear communication and stakeholder understanding.</p> <p>Visual Cues and Tools: Uses slides, workflow diagrams, and decision trees to convey complex workflows to clients; relies more on text and verbal communication for internal developers.</p> <p>Consistency and Standardization: Recognizes the need for standardized visual cues and consistent communication methods, mainly using simple, standard visualizations and tools like Excel and PowerPoint.</p> <p>Practical Tools: Using heat maps and the traffic light system effectively manages information overload and drives meaningful conversations.</p> <p>Overall, the respondent prioritizes clear communication, stakeholder understanding, and gradual introduction of complexity in their visualizations, emphasizing standardization and practicality.</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Simplicity and Focus: - Simple Processes: Keeps processes simple and focused on business variables for effective implementation. - Tracking Variances: Uses visual tools like waterfalls and heat maps to track variances and inform budgeting and forecasting cycles.</p> <p>Future Applications: - Process Fine-Tuning: Suggests fine-tuning processes based on previous cycles' experiences and learnings. - Automation and AI: Potential use of automation and AI for data analysis and trend identification.</p> <p>Effectiveness of Visualization: - Communication and Verification: Visualization aids communication, understanding, and verification. - Self-Service Understanding: Helps in self-service understanding, immediate issue identification, and maintaining structured meetings and reviews.</p> <p>Elaborating on Using Visual Clues to Convey Workflow Understanding</p> <p>Visual Tools and Techniques:</p> <p>Flowcharts and Diagrams: Uses flowcharts and diagrams to represent the workflow visually, showing each step and decision point.</p> <p>Colour Coding: Uses colours to indicate different steps, variances, or essential information, enhancing clarity and focus.</p> <p>Symbols and Icons: Employs symbols and icons to represent different actions or statuses within the workflow.</p> <p>Swim Lanes: Visualizes areas of responsibility and process flows using swim lanes, clarifying who is responsible for each part of the process.</p> <p>Heat Maps: Heat maps highlight unexpected values or critical areas within the workflow.</p> <p>Dashboards: Dashboards provide an at-a-glance workflow overview, showing key metrics and areas needing attention.</p> <p>Training and Demonstrations:</p> <p>Interactive Demonstrations: Uses demonstration environments to show how processes work in practice, helping SMEs visualize and understand the workflow.</p>	

Question	Common Themes SMEs	Common Themes SEs
	<p>Workshops: Conduct workshops to collaboratively discuss and visualize workflows, gather feedback, and adjust.</p> <p>Feedback and Adaptation:</p> <p>Iterative Improvement: Encourages feedback from SMEs and adapts visualizations based on their input to ensure the workflow is accurately and effectively conveyed.</p> <p>Clear and Concise Language: Combines visual tools with clear and concise language to ensure comprehensive understanding.</p> <p>Overall Impact.</p> <p>Enhanced Understanding: Visualization tools and visual clues significantly enhance the understanding of workflows, making complex processes more accessible and comprehensible.</p> <p>Effective Communication: Visualizations facilitate effective communication of expert decisions and processes, ensuring all SMEs are on the same page.</p> <p>Consistent Implementation: Using visual tools across projects helps maintain clarity and standardization, improving overall implementation and outcomes.</p>	
<p>What kinds of information do you provide to the system experts to code the workflow and assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in your region.</p>	<p>Data Conversion and Reporting Requirements: Information on data conversion processes, including areas needing checks. Detailed business drivers, key milestones, and reasons behind decisions. Step-by-step workflow processes, especially for billing in specific regions. Visual workflows, report layouts, and output examples.</p> <p>Communication and Configuration Systems: Use of structured meetings, reviews, and workshops to ensure clear communication. Written descriptions and strategy documents were updated throughout the project. Screenshots or videos demonstrating processes for clarity.</p> <p>Use of Visualizations: Tools and Techniques:</p>	<p>Eliciting Requirements: Focus on gathering requirements from clients rather than strictly defining workflows initially. Use a requirements matrix to work backward and determine appropriate visualizations.</p> <p>Detailed Documentation: Create detailed business process documents using traditional swim lane methodology. Use verbose descriptions in Word documents to describe business requirements. Develop detailed technical documents for more technical aspects.</p> <p>Visualizations for Workflow and Assumptions: While visualizations are not heavily utilized for coding workflows and assumptions, they are employed to demonstrate processes to business stakeholders.</p> <p>Utilize standard visualizations like bar charts, stack bar charts, and workflow diagrams to highlight processes and identify bottlenecks.</p> <p>Systems for Communication and Configuration: Standard Tools:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>PowerPoint presentations for process flow diagrams and other visuals.</p> <p>Microsoft Visio and similar tools for creating flow charts and diagrams.</p> <p>Dashboards and interactive tools for dynamic communication.</p> <p>Power BI for data visualization and representation.</p> <p>Excel validation sheets with colour-coding to show discrepancies in data.</p> <p>Purpose and Timing:</p> <p>Visualizations are used to help understand new methods and data availability.</p> <p>Visual aids are employed to ensure consistency and comprehensibility across all audiences.</p> <p>Diagrams, colour codes, symbols, and icons indicate different process steps and variances.</p> <p>Visualizations are often built later in the project to verify accuracy and identify areas needing attention.</p> <p>Examples:</p> <p>Billing Workflow Visualization:</p> <p>The step-by-step process is illustrated with flow charts and diagrams.</p> <p>Use of colours and icons to indicate user input steps and information steps.</p> <p>Consistent visual tools to ensure all stakeholders understand the workflow.</p> <p>Data Conversion Visualization:</p> <p>Explicit highlighting of areas where data is passing or failing.</p> <p>Use of standard symbols and colours for workflow diagrams to ensure consistency.</p> <p>Visual validation sheets to compare client data with expert database values.</p> <p>Conclusion:</p> <p>Participants use a mix of detailed discussions, strategy documents, and various visual tools to communicate information to system experts.</p> <p>Visualizations are crucial in conveying complex workflows and ensuring that all stakeholders are aligned, though they are often developed as the project progresses to ensure accuracy and address discrepancies.</p>	<p>Use standard tools like Excel and PowerPoint for communication and configuration.</p> <p>Excel is used internally to list stages and support verbal and text-based communication.</p> <p>PowerPoint is used to create visually appealing slides for client-facing materials.</p> <p>Use of Visualizations:</p> <p>Client-Facing Visualizations:</p> <p>Transform workflow diagrams into more visually appealing PowerPoint slides for client presentations.</p> <p>Use decision trees in visual formats to explain decision points in workflows (e.g., approval processes, percentage-based triggers).</p> <p>Internal Communication:</p> <p>Heat maps are used internally to drill down on data, but only sometimes with clients.</p> <p>Visual representations of workflow states and decision points support internal understanding.</p> <p>Emphasize using simple visual tools to ensure clarity and avoid information overload.</p> <p>Opportunities for Improvement:</p> <p>Integration of Visual Tools:</p> <p>Recognize the potential for better integration of visual tools in workflow communication and configuration processes.</p> <p>Acknowledge the need to improve visualizations when communicating with developers and system experts.</p> <p>Standardization and Simplicity:</p> <p>Prefer standard visualizations for ease of understanding and consistency.</p> <p>Focus on simplicity to avoid confusing stakeholders and ensure clear communication.</p> <p>Examples:</p> <p>Billing Workflow:</p> <p>Use workflow diagrams and decision trees to show the steps and decision points of the billing process.</p> <p>Create visually appealing slides to present these workflows to clients.</p> <p>Heat Maps and Workflow States:</p> <p>Use heat maps to identify bottlenecks and drill down on specific data points.</p> <p>Visual representations of workflow states (e.g., approval needs) help understand and explain processes.</p> <p>Conclusion:</p> <p>Participants emphasized the importance of clear, purpose-driven, and simple visualizations for conveying information to system experts. While detailed text-based documentation is crucial for technical communication, visual tools are primarily used for client-facing materials and identifying process</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Workshops and Forums: Both in-person and remote workshops are common for discussing and agreeing upon the information needed for system configuration and calculations. Workshops bring together SMEs from different regions to ensure a comprehensive understanding and alignment of requirements. Forums and initial discussions are used to set up configurations, switches, and options within each module, with ongoing updates as implementation progresses. Standardization and Cultural Buy-in: Cultural buy-in and understanding of the business case are critical for agreement among SMEs. Standardized notations for daily processes are often lacking, making reliance on visual aids necessary for understanding and agreement. A signed-off document created during workshops is a basis for configuring the system. Use of Visualizations: Tools and Techniques: Visual aids such as PowerPoint presentations, graphs, flow charts, diagrams, and Excel validation sheets are used extensively. Standard colours and symbols in workflow diagrams ensure consistency and clarity. Visual tools like Power BI and other graphical representations help highlight critical information and discrepancies. Purposes: Visualizations help SMEs understand new processes and data, especially when transitioning from legacy systems. They are used to present findings, get user feedback, and validate the system with developers and SMEs. Visual tools facilitate cultural buy-in and help focus on business variables for effective implementation.</p>	<p>bottlenecks. There is a recognized need for better integration of visual tools in internal communications.</p> <p>Workshops and Forums: Facilitation: Workshops are facilitated by technical or business owner subject matter experts (SMEs), often involving application consultants. Decision-Making: These workshops are the main forum for SMEs to agree on system configuration and calculations, with decisions typically suggested by application consultants and agreed upon by business owners. Regional Variations: Local Adaptations: Some calculations are regionally driven, while others are more global, requiring different metrics for different regions. Documentation of Decisions: Clarity and Understanding: Decisions are recorded and circulated through meeting minutes or workshop outputs to ensure clear understanding and agreement. Black and White: Emphasis on having decisions documented clearly to avoid misunderstandings. Use of Visualizations: Current Use and Effectiveness: Limited Use: Visualizations are not heavily utilized for agreeing on configurations or calculations, with a few exceptions. Primary Tools: Workshops mainly use the software to demonstrate capabilities and impacts rather than separate visual aids. Some Visual Aids: There might be occasional slides, but the primary reliance is on large spreadsheets and verbal/text-based communication. Preferred Visual Tools: Heat Maps: Effective for displaying 2-3 data points, highlighting important information without overwhelming the viewer. Standard Charts: Bar charts and stack bar charts are preferred for their simplicity and effectiveness in conveying information. Room for Improvement: Need for More Visualizations: Recognition of the potential benefits of using more visualizations in the agreement process suggests that the current approach might not be optimal. Future Implementation: Acknowledgment of the value of visualizations for effective communication and verification of decisions, indicating an area for growth. Examples and Practices: Billing Workflow: Workflow Diagrams: Diagrams that show different steps and decision points in workflows, transformed into visually appealing slides for client presentations. Decision Trees: Visual representation of decision points within workflows to explain specific actions.</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Visualizations are particularly handy in testing to identify data passing or failing and highlight issues.</p> <p>Examples:</p> <p>Process Summaries and Flow Arrows: Workflows and process summaries represent the business process visually to ensure common understanding among SMEs and developers. Flow arrows show the direction of information flow, enhancing clarity during workshops.</p> <p>Validation and Reporting: Excel validation sheets with colour coding indicate discrepancies between client data and expert database values.</p> <p>Visual representations of output reporting help SMEs understand key drivers and agree on the standard data model.</p> <p>Conclusion: Participants use a mix of workshops, forums, and visual tools to ensure SMEs agree on the information required for system configuration and calculations. Visualizations are crucial in facilitating understanding, ensuring consistency, and validating processes, although they are often developed later in the project to address specific needs and discrepancies.</p>	<p>Workshops Visualization: Software Demonstrations: The primary form of visualization in workshops is demonstrating the software itself, showing what it can do and its impact. Limited Other Visuals: Apart from software demonstrations, a few additional visual aids are used, with occasional slides mentioned.</p> <p>Conclusion: Workshops and forums are the primary means for SMEs to agree on system configurations and calculations, facilitated by technical or business owner SMEs. While there is some use of visualizations and straightforward and effective tools like heat maps and standard charts, the current approach relies more on software demonstrations and text-based documentation. There is potential for improvement in integrating more visual tools to aid the agreement process, enhancing clarity and understanding among stakeholders.</p>
<p>How do you, as an individual, make the new knowledge your own and apply this within the next budgeting and forecasting cycle? What visual cues or tools assist the process?</p>	<p>Testing and Feedback: We are testing new knowledge in a controlled environment before full implementation. We are gathering user feedback post-implementation to make necessary adjustments. I am reviewing updated strategy documents throughout the implementation process. We document lessons learned, including budget overruns, scope discrepancies, and change orders.</p> <p>Simplicity and Iteration: I am keeping processes simple and using experiences and learnings from previous cycles to fine-tune approaches. I am using internal reviews and project closure meetings to consolidate and present gathered information.</p>	<p>Developer Preferences and Consistency: Developers tend to gravitate towards certain consistent styles and themes in visualizations, which suggests that they internalize effective visualization techniques over time.</p> <p>Lack of Formal Process: There needs to be a formal process at the end of projects to evaluate the effectiveness of visualizations or refine them for future use.</p> <p>Knowledge Transition and Client Enablement: Focus on enabling clients to create visualizations in the future rather than refining the internal team's knowledge base. Knowledge transfer involves forums where admin staff initially guide clients, and later, clients provide feedback to identify gaps or issues.</p> <p>Simplicity in Visualization: I consistently emphasize simple and easy-to-understand visualizations as a fundamental principle applied in future cycles.</p> <p>Visual Cues and Tools: Knowledge Transfer Forums: Two main forums for knowledge transfer:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>I am maintaining a library of critical customizations and visual summaries for reference.</p> <p>Visual Cues and Tools: Visualization Tools: PowerPoint presentations, Excel spreadsheets, flow diagrams, and waterfalls are used to understand and communicate new knowledge. Data visualization through standard interfaces to identify issues or areas for refinement in the conversion process. They are reporting tools with dashboards and colour-coded tiles to convey various types of information.</p> <p>Specific Visual Aids: Maps of data conversion, data mapping, testing logs, and architectural diagrams of workflows. Graphs, heat maps, and profit and loss heat maps to track variances and highlight achievements and areas needing improvement.</p> <p>Icons and presentation materials for a consistent visual representation of standard business processes.</p> <p>Advanced Tools: Potential use of automation and AI for data analysis and trend identification, particularly with large data volumes. High-level visualizations of plans or schedules to understand workflows and potential workloads or work buckets.</p> <p>Examples: Controlled Testing and Data Mapping: We are testing new knowledge in controlled environments with visual aids like maps of data conversion to ensure accuracy and readiness before full-scale implementation. Data mapping and testing logs to track and refine the conversion process.</p> <p>Project Closure and Internal Reviews: We are utilizing project closure meetings to present gathered information, using PowerPoint and Excel to summarize and communicate findings.</p>	<p>Admin staff passing information to client staff. Client staff gives feedback to admin staff in later stages.</p> <p>This cycle of knowledge exchange helps identify gaps or issues in the setup.</p> <p>Use of Software as Visualization: Primarily use software to visualize information with limited use of dedicated visual aids or slides.</p> <p>Large spreadsheets are used for inputting codes and information, but these could benefit from more visualization elements.</p> <p>Documentation and Clear Communication: Emphasizes recording decisions through meeting minutes or workshop outputs, ensuring clear understanding. Uses written records to ensure consistent communication and understanding across team members.</p> <p>Current Practices and Room for Improvement: Limited Use of Visualizations: Acknowledges limited use of visualizations in the current process, relying more on text-based documentation and interactive software. Suggests the need to incorporate more visual aids and visualizations to enhance understanding and application.</p> <p>Tools and Visual Cues: Note that a few slides are used, but there is room to use more visualizations. Identifies the potential to incorporate more visual aids, especially in large spreadsheets, to enhance visualization elements.</p> <p>Future Trends: AI Integration: Sees potential for AI integration in future visualizations, although other aspects might be more critical.</p> <p>Dynamic Information Presentation: Emphasizes the importance of dynamic information presentation, using tools like Power BI for creating visualizations with different filters and views.</p> <p>Voice Interaction: Suggests that future developments include voice interaction for ease of use, allowing users to explain what they want rather than typing it in.</p> <p>Conclusion: While the current process relies heavily on text-based documentation and interactive forums for knowledge transfer, there is recognition of the potential to enhance the use of visualizations. Emphasizing simplicity and consistency in visualizations, along with incorporating more visual aids, can improve the internalization and application of new knowledge in future budgeting and forecasting cycles. The future of visualizations includes potential AI integration, dynamic information presentation, and voice interaction to enhance ease of use and understanding.</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>We are conducting internal reviews to document lessons learned, with visual summaries to confirm and adjust processes for the next cycle.</p> <p>Visual Summaries and Libraries: I maintained visual summaries and a library of customizations with icons and other presentation materials to facilitate future implementations.</p> <p>Conclusion: Individuals use a variety of testing, feedback, and visualization tools to make new knowledge their own and apply it in subsequent budgeting and forecasting cycles. Visual cues and tools are integral in communicating, understanding, and refining processes, although the level of standardization varies. Advanced tools like AI and high-level visualizations also aid in managing and analyzing large data volumes, ensuring continuous improvement and effective implementation.</p>	
Does visualization assist with communication, process, or verification?	<p>Communication: Enhancement of Understanding: Visuals help subject matter experts (SMEs) and other stakeholders understand new processes and data more efficiently than textual descriptions. Necessity for Workshops: Visual aids like PowerPoint presentations are crucial for effective communication during workshops and meetings. Accessibility: Visualization makes information more accessible and practical, allowing more people to quickly understand complex data and processes.</p> <p>Process: Process Representation: Visualizations represent business processes with various steps, making it easier to present, follow, and understand them. Focus in Governance: Using visuals in governance meetings helps focus on critical areas, making the meetings more efficient. Structure Maintenance: Visualization aids in maintaining structured meetings and reviews by providing precise and organized representations of processes and data.</p> <p>Verification:</p>	<p>The respondent's approach to using visualizations in their projects aims to keep their visualizations as simple as possible to ensure stakeholders can easily understand them. They also use visualizations to elicit client requirements rather than dictate workflows. Additionally, they encouraged internal stakeholders to use visualizations to improve communication and verification and to ensure that the knowledge gained from projects is readily accessible to the business.</p> <p>They start with simple visualizations and only add complexity if necessary, avoiding "kitchen sink" approaches that overwhelm stakeholders. They use visualizations to tell a story and highlight important information for different levels of stakeholders. They prefer standard, simple visualizations like stack bar charts over complex or custom visualizations. Heat maps are used effectively as they typically focus on 2-3 data points and allow for drill-down capabilities. The respondent's team encourages co-resourcing and knowledge transfer to enable clients to create visualizations in the future.</p> <p>Their projects primarily use visualizations for communication and verification purposes.</p> <p>Communication: The respondent strongly emphasizes that visualization is vital for communication. They state that visualizations "tell the story" And are used for "highlighting information for stakeholders at different levels of the business." Visualizations help convey what information stakeholders should be interested in.</p> <p>Verification: The respondent also confirms that visualization aids in verification. They mention two specific examples: - Event-driven reports</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Identifying Issues: Visual aids help identify gaps in data, issues in processes, and areas needing attention during the testing and verification phases.</p> <p>Comparison with Expected Outcomes: Visualizations provide a clear overview of what has been done, allowing for easy comparison with expected outcomes.</p> <p>Less Reliance on Text: While verification still involves detailed text and spreadsheets, visualization assists in the initial overview and identification of discrepancies, especially in complex systems with many interconnected parts.</p> <p>Examples and Tools:</p> <p>Workflow Visualization:</p> <p>Easier Visualization: Visual representations of workflows help people understand complex processes and immediately identify any issues or successes.</p> <p>PowerPoint Presentations: Essential for workshops to communicate module information and processes effectively.</p> <p>Reports and Dashboards:</p> <p>Self-Service Understanding: Visual tools like dashboards and reports allow users to understand the provided information independently.</p> <p>Distinguishing Areas and Processes: Reports and dashboards visually differentiate various areas and processes, making it easier to convey statistics and requirements.</p> <p>Governance Meetings:</p> <p>Focused Discussions: Visuals help change the focus of governance meetings to critical areas, improving efficiency and effectiveness.</p> <p>Conclusion:</p> <p>Visualization is a powerful tool that significantly enhances communication, process understanding, and verification. It makes complex information more accessible, aids in representing and understanding processes and helps identify issues during verification. While detailed text and spreadsheets are still necessary for thorough verification, visualization provides a crucial initial</p>	<p>highlighting issues like outstanding invoices from a year ago. - Charts that make it easy to spot outliers, such as in accounts receivable by department.</p> <p>Process: While the respondent considers this category more ambiguous, they mention that visualization can support efficient processes. For example, they sometimes create reports highlighting process bottlenecks, such as identifying steps that consistently take longer than expected.</p> <p>The respondent concludes that visualization assists with communication and verification, while its role in process support could overlap with the other two categories.</p> <p>Sales Process vs. Implementation: Some visualizations are used in the sales process but don't carry over into the actual project implementation. The respondent states, "We do some in the sales process, but I don't think they. Follow those two into the actual. Project."</p> <p>Focus on Product Demonstration: Instead of visualizations, they focus on walking clients through the product. The respondent mentions, "I think a lot of it's based on. Let me walk you through using it. Product rather than having a visualization."</p> <p>Potential for Improvement: The respondent acknowledges that they could use more visualizations in the implementation process. She notes that someone on her team is very visual, which has led to better visualizations in the sales process, suggesting there's potential for more use in implementations.</p> <p>Lack of Specific Examples: The respondents must provide concrete examples of visualizations used for communication, process, or verification in their current implementation practices.</p> <p>In summary, while visualizations have some role in the sales process, they appear less utilized for communication, process, or verification during actual implementations.</p> <ol style="list-style-type: none"> 1. Crucial for effective communication: <ul style="list-style-type: none"> - The respondents believe visualizations are "crucial" and "critical" for effective communication. - They help ensure everyone understands and agrees upon decisions. 2. Adaptability to different scenarios: <ul style="list-style-type: none"> - Visualizations can be used for specific decisions (e.g., updating metrics) and broad concepts (e.g., program risks, schedules, delivery management). - The type of visualization used depends on the audience and the question. 3. Ease of understanding: <ul style="list-style-type: none"> - The respondents prefer visualizations because they are more accessible for people to understand and consume. - They help present large quantities of information in a more digestible format. 4. Consistency in communication: <ul style="list-style-type: none"> - Visualizations provide a consistent way of presenting information, unlike "many words on a bit of paper."

Question	Common Themes SMEs	Common Themes SEs
	<p>overview and facilitates more effective communication and process management.</p>	<p>5. Verification: - While not explicitly stated, the emphasis on ensuring decisions are "well understood and agreed by everybody" suggests that visualizations aid in the verification process.</p> <p>6. Process improvement: - The respondents imply that visualizations can improve processes by making information more accessible and understandable to all stakeholders. In summary, the respondents strongly believe that visualizations are valuable tools that assist in communication, can improve processes, and help with verification by ensuring consistent understanding across team members. He sees them as preferable to text-heavy communication in many scenarios.</p> <p>Summary of Explanatory Qualitative Themes Role of Visualization in Projects: Simplicity and Accessibility: Emphasizes keeping visualizations simple to ensure stakeholders easily understand them. It starts with basic visualizations and only adds complexity if necessary to avoid overwhelming stakeholders. Purpose-Driven Visualizations: Uses visualizations to elicit client requirements rather than dictate workflows. Focuses on telling a story and highlighting important information for different levels of stakeholders. Standard, simple visualizations like stack bar charts are preferred over complex or custom visualizations. Effective Tools: Heat maps are particularly effective, focusing on 2-3 data points and allowing for drill-down capabilities. Event-driven reports and charts help highlight issues and spot outliers for verification purposes. Application in Communication, Process, and Verification: Communication: Visualization is vital for communication, helping to "tell the story" and highlight key information for stakeholders at various levels. Ensures that decisions are well understood and agreed upon by all parties. Provides a consistent way of presenting information, making it easier to digest large quantities of information. Verification: Visualizations assist in verification by making it easy to spot issues like outstanding invoices and outliers in accounts receivable. Event-driven reports and charts help identify and verify discrepancies and anomalies. Process Support:</p>

Question	Common Themes SMEs	Common Themes SEs
		<p>Visualizations support process efficiency by identifying bottlenecks, such as steps that consistently take longer than expected.</p> <p>While process support is considered more ambiguous, it overlaps with communication and verification.</p> <p>Current Use and Potential for Improvement:</p> <p>Sales Process vs. Implementation:</p> <p>Visualizations are used more in sales but are only somewhat utilized in project implementation.</p> <p>The focus during implementation is on walking clients through the product rather than using visualizations.</p> <p>Potential for Improvement:</p> <p>Acknowledges the need for more visualizations in the implementation process.</p> <p>Recognizes the value of visualizations in improving communication and verification during implementation.</p> <p>Team Dynamics:</p> <p>Encourages co-resourcing and knowledge transfer to enable clients to create visualizations in the future.</p> <p>Developer preferences for consistent styles and themes suggest internalizing effective visualization techniques over time.</p> <p>Key Points from the respondent's Response:</p> <p>Crucial for Effective Communication:</p> <p>Visualizations are critical for effective communication, ensuring decisions are well understood and agreed upon.</p> <p>Adaptability and Ease of Understanding:</p> <p>Depending on the audience and question, visualizations can be adapted for specific decisions and broad concepts.</p> <p>They make information easier to understand and consume, providing a consistent presentation.</p> <p>Verification and Process Improvement:</p> <p>Visualizations aid in the verification process by ensuring transparent and agreed-upon decisions.</p> <p>They can improve processes by making information accessible and understandable to all stakeholders.</p> <p>Conclusion:</p> <p>Visualizations play a crucial role in communication, verification, and process support. Keeping visualizations simple and purpose-driven helps ensure they are easily understood and effectively highlight key information. While there is room for improvement in integrating visualizations into implementation processes, their value in enhancing communication and verification is well recognized. The future potential includes broader use in implementation and leveraging dynamic tools like heat maps to improve process efficiency and stakeholder understanding further.</p>

Question	Common Themes SMEs	Common Themes SEs
<p>What do you see in the future for visualization?</p>		<p>AI-Generated Commentary: AI interpretation of numbers and commentary on visualizations is an exciting development that will become more common.</p> <p>Personalized Insights: Potential for AI-generated commentary to be refined and tailored for individual firms, enhancing accuracy and relevance.</p> <p>Current Limited Use: The respondent's firm uses AI sparingly for visualizations or forecasting.</p> <p>Increasing Demand and Adoption:</p> <p>Growing Expectations: Increasing demand for visual representation of data, moving from traditional reports with many numbers to more visual formats.</p> <p>Tools Like Power BI: Tools like Power BI are becoming more prevalent, facilitating the creation of dynamic and interactive visualizations.</p> <p>Mobile Accessibility: Emphasis on the importance of accessing visualizations on mobile devices, enabling viewing on phones and tablets.</p> <p>Progressive Adoption:</p> <p>Gradual Sophistication: As people become accustomed to basic visualizations, they will gradually ask for more complex ones, indicating a progressive adoption process.</p> <p>Potential for Growth: People may initially need to realize the benefits of visualizations, but as they start seeing them, the demand and utility will grow.</p> <p>Industry Adaptation: Industries traditionally less visual, like the legal sector, will likely move towards more visual representations of information.</p> <p>Dynamic Information Presentation:</p> <p>Multiple Views: Dynamic presentation of information, allowing for different filters and views of the same data set, enhancing flexibility and depth of analysis.</p> <p>Voice Interaction:</p> <p>Future Development: Using voice interaction to explain what is wanted, rather than typing, could be a future development, though it is seen as a "nice to have" rather than critical.</p> <p>Focus on Ease of Understanding:</p> <p>Simplifying Complex Data: Emphasis on presenting complex information in an easy-to-understand manner, using widely understood terminology.</p> <p>User-Friendly Presentations: Moving towards more user-friendly data presentations, making information accessible to all users.</p> <p>Challenges in Implementation:</p> <p>Implementation Difficulties: Recognizing that while these advancements are possible, effectively implementing them remains challenging.</p> <p>Overall Themes:</p> <p>AI and Personalization: The future of visualization includes integrating AI for commentary and insights, with the potential for personalization.</p> <p>Dynamic and Interactive Tools: Increasing the use of dynamic and interactive tools like Power BI to present data flexibly and engagingly.</p>

Question	Common Themes SMEs	Common Themes SEs
		<p>Mobile and Accessible Visualizations: Emphasis on making visualizations accessible on mobile devices, ensuring they are available anywhere.</p> <p>Gradual Adoption and Growth: Progressive adoption of more sophisticated visualizations as users become familiar with basic ones, leading to increased demand and utility.</p> <p>Ease of Understanding: Prioritizing simplicity and ease of understanding in presenting complex data to ensure accessibility for all users.</p> <p>Voice Interaction: Future potential for voice interaction in creating and navigating visualizations.</p> <p>Implementation Challenges: Acknowledging the challenges in effectively implementing these advanced visualization techniques.</p> <p>Overall, the future of visualization is seen as increasingly dynamic, interactive, and user-friendly, with significant potential for AI integration and personalized insights. The emphasis will be on making visualizations accessible, understandable, and flexible to meet growing expectations and demands.</p>
Do you think about the proposed budgeting and forecasting system automation using visualization as feedback?		<p>AI Integration:</p> <p>Acknowledgment of Potential: Recognizes the potential of AI in forecasting by analyzing historical data to project future trends, even though AI is not currently used.</p> <p>Interactive Reports: Envisions future reports providing visual data alongside AI-generated written or spoken commentary.</p> <p>Heat Maps:</p> <p>Current Use and Effectiveness: Heat maps visualize 2-3 data points effectively.</p> <p>Application in P&L and Budgeting: Finds heat maps interesting for P&L and budgeting but questions whether people generally understand them.</p> <p>Value in Simplification: Believes heat maps can simplify understanding of budget information by showing what's on or off track.</p> <p>User Understanding and Adoption:</p> <p>Simplicity for Specific Audiences:</p> <p>Straightforward Visuals for Lawyers: Emphasizes the need for straightforward visualizations for lawyers, such as simple gauges indicating good or bad.</p> <p>Adapting to Audience Needs: Recognizes the importance of tailoring visualizations to the audience's familiarity and comfort with data nuances.</p> <p>Progressive Adoption and Growth Potential:</p> <p>Gradual Introduction: Suggests starting with simple dashboard tiles showing primary data and adding complexity as users become comfortable.</p> <p>Increased Demand: Believes that as users get accustomed to visualizations, they will request more detailed and sophisticated ones.</p> <p>Growth through Exposure: This states that users might only realize the benefits of visualizations once they see them in action, leading to increased adoption over time.</p>

Question	Common Themes SMEs	Common Themes SEs
		<p>Current Practices and Challenges:</p> <p>Lack of Out-of-the-Box Solutions:</p> <p>Implementation Difficulty: Notes the absence of technology that can quickly implement visualization-driven budgeting and forecasting systems.</p> <p>Transforming Data: Currently uses data from budgeting tools and converts it into more easily consumable information.</p> <p>Reporting Layer:</p> <p>Separate from Core Tool: Views visualization as a reporting layer on top of budgeting tools rather than an integrated feature.</p> <p>Enhanced Understanding: Sees value using visualizations to make budgeting and forecasting data more accessible and understandable.</p> <p>Industry Perspective:</p> <p>Industry Maturity:</p> <p>Legal Industry Context: Highlights that the legal industry could be more mature using technology and data, implying significant room for improvement.</p> <p>Potential for Improvement: Recognizes the potential for visualizations to enhance understanding and utilization of budgeting and forecasting data in the industry.</p> <p>Overall Themes:</p> <p>AI and Interactive Reporting: The future includes AI integration for generating commentary and insights and enhancing the interactivity and value of reports.</p> <p>Heat Maps and Simplification: Heat maps are valuable for simplifying complex information and highlighting key data points, particularly in P&L and budgeting contexts.</p> <p>User-Centric Visualizations: Emphasizes the need for straightforward visualizations tailored to specific audiences, focusing on gradual adoption and increased sophistication over time.</p> <p>Implementation Challenges: Acknowledges the lack of out-of-the-box solutions for integrating visualizations into budgeting and forecasting systems, suggesting data transformation and separate reporting layers.</p> <p>Growth and Industry Adaptation: Anticipates growth in visualization use as users become more familiar with its benefits, particularly in industries like legal that have room for technological advancement.</p> <p>Overall, respondents see significant potential in using visualizations to enhance budgeting and forecasting systems, focusing on AI integration, simplicity, user-centric design, and gradual adoption. Despite current challenges, there is optimism about visualizations' future value and impact in this context.</p>

Table 18: Comparison of SMEs Vs. SEs responses

	Question	Common Themes SMEs	Common Themes SEs
	Summary	<p>Visualization aids in Understanding workflows</p> <p>Training and Communication: Implementation and Testing: Use of Visual Aids: Various visual aids such as Microsoft Visio, flowcharts, diagrams, and PowerPoint presentations are used.</p> <p>Consistency and Standardization:</p> <p>Workshops and Demonstrations:</p> <p>Feedback and Adjustments: Post-Reporting and Colour Coding:</p> <p>Crucial Role of Visualization in Communication:</p> <p>Methods of Conveying Expertise:</p> <p>Information for System Experts:</p> <p>Structured Meetings and Reviews:</p> <p>Workshops and Cultural Buy-In:</p> <p>Simplicity and Focus:</p> <p>Future Applications:</p> <p>Effectiveness of Visualization</p> <p>Implementation Process:</p> <p>Use in Large Data Sets:</p> <p>Late Integration Issue:</p>	<p>Simplicity is Key:</p> <p>Purpose-Driven Visualizations:</p> <p>Audience-Centric:</p> <p>Standard Over Custom:</p> <p>Practical Tools:</p> <p>Uses heat maps to display 2-3 data points with drill-down capabilities.</p> <p>Traffic Light System:</p> <p>Communication and Verification:</p> <p>Communication Tool:</p> <p>Verification Aid:</p> <p>Process Support:</p> <p>Client Enablement and Consistency:</p> <p>Client Enablement:</p> <p>Consistency:</p> <p>Current Use and Future Potential:</p> <p>Limited Current Use:</p> <p>More Prevalent in Sales:</p> <p>Room for Improvement:</p> <p>Evolving Expectations:</p> <p>Mobile Accessibility:</p> <p>Simplification and Progressive Implementation:</p> <p>Simplicity for Certain Audiences:</p> <p>Progressive Implementation:</p> <p>Future Trends and Challenges:</p> <p>Growing Trend:</p> <p>AI Integration:</p> <p>Voice Interaction:</p> <p>Simplification of Complex Data:</p>

Question	Common Themes SMEs	Common Themes SEs
		<p>Implementation Challenges:</p> <p>Overall Implications:</p> <p>Visualizations are crucial for effective communication, data verification, and supporting processes. Emphasizing simplicity, standardization, and audience-centric approaches can enhance understanding and enable better decision-making. There is significant potential to improve the use of visualizations in technical communication and project implementation, with evolving client expectations driving the need for more dynamic, accessible, and user-friendly visual tools.</p>
<p>How many years have you worked implementing systems in the legal industry?</p>		
<p>How do you convey and adapt what you base your subject matter expert decisions on to other SMEs within your region? Please also elaborate on using visual clues to convey this knowledge when conveying workflow understanding.</p>	<p>Conveying Workflow Understanding:</p> <p>Data Conversion and Testing:</p> <p>Process Visualization: Flowcharts, waterfalls, dashboards, and swim lanes</p> <p>Training and Communication:</p> <p>Implementation and Testing:</p> <p>Issue Identification:</p> <p>Verification and Communication:</p> <p>Use of Visual Aids:</p> <p>Variety of Tools: Uses visual aids such as Microsoft Visio, flowcharts, diagrams, PowerPoint presentations, heat maps, mind maps, and Excel.</p> <p>Visual Cues and Symbols:</p> <p>Consistency and Standardization:</p> <p>Consistent Use Across Projects:</p>	<p>Simplicity:</p> <p>Purpose-Driven:</p> <p>Gradual Complexity:</p> <p>Audience-Focused:</p> <p>Effective Use of Heat Maps:</p> <p>Finds heat maps particularly effective for displaying 2-3 data points,</p> <p>Standard Visualizations:</p> <p>Visual Cues and Tools for Workflow Understanding:</p> <p>Use of Slides for Clients:</p> <p>Workflow Diagrams and Decision Trees:</p> <p>Internal Communication with Developers:</p> <p>The respondent's Specific Approaches:</p> <p style="padding-left: 40px;">Simplistic High-Level Plans:</p> <p>Detailed Focus Areas:</p> <p>Excel-Based Visualizations:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Standardized Visuals: Workshops and Demonstrations: Collaborative Workshops: Visual Feedback: Feedback and Adjustments: Post-Implementation Feedback: Presentation of Adjustments: Reporting and Colour Coding: Dashboards with Colour-Coded Tiles: Crucial Role of Visualization: Essential for Communication: Daily Necessity: Methods of Conveying Expertise: Process Diagrams and Flowcharts: Process diagrams, flowcharts, and standard profit and loss heat maps Information for System Experts: Structured Meetings and Reviews: Simplicity and Focus: Future Applications: - Process Fine- Tuning: Automation and AI: Effectiveness of Visualization: Communication and Verification: Self-Service Understanding: Elaborating on Using Visual Clues to Convey Workflow Understanding Visual Tools and Techniques: Flowcharts and Diagrams: Colour Coding</p>	<p>Higher-Level Information Presentation: Traffic Light System: Lack of Consistent Visual Standards: Summary: Approach Priorities: Emphasizes simplicity, purpose-driven visualizations, gradual complexity, and audience focus to ensure clear communication and stakeholder understanding. Visual Cues and Tools: Uses slides, workflow diagrams, and decision trees to convey complex workflows to clients; relies more on text and verbal communication for internal developers. Consistency and Standardization: Recognizes the need for standardized visual cues and consistent communication methods, mainly using simple, standard visualizations and tools like Excel and PowerPoint. Practical Tools: Using heat maps and the traffic light system effectively manages information overload and drives meaningful conversations. Overall, the respondent prioritizes clear communication, stakeholder understanding, and gradual introduction of complexity in their visualizations, emphasizing standardization and practicality.</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Symbols and Icons: Employs symbols and icons to represent different actions or statuses within the workflow.</p> <p>Swim Lanes:</p> <p>Heat Maps:</p> <p>Dashboards:</p> <p>Training and Demonstrations:</p> <p>Interactive Demonstrations: and understand the workflow.</p> <p>Workshops: Feedback and Adaptation:</p> <p>Iterative Improvement:</p> <p>Clear and Concise Language:</p> <p>Overall Impact.</p> <p>Enhanced Understanding:</p> <p>Effective Communication:</p> <p>Consistent Implementation:</p>	
<p>What kinds of information do you provide to the system experts to code the workflow and assumptions? What systems do you use to help in communication and configuration? Please also elaborate on the use of Visualizations to convey this knowledge. An example would be the stepped process of how the billing workflow would occur in your region.</p>	<p>Data Conversion and Reporting Requirements:</p> <p>Information on data conversion processes,</p> <p>Step-by-step workflow processes,</p> <p>Communication and Configuration Systems:</p> <p>Use of Visualizations:</p> <p>Tools and Techniques:</p> <p>PowerPoint for process flow</p> <p>Microsoft Visio</p> <p>Dashboards and interactive tools</p> <p>Power BI</p> <p>Excel validation sheets with colour-coding</p>	<p>Eliciting Requirements:</p> <p>Detailed Documentation:</p> <p>Visualizations for Workflow and Assumptions:</p> <p>Systems for Communication and Configuration:</p> <p>Standard Tools:</p> <p>Use standard tools like Excel and PowerPoint for communication and configuration.</p> <p>Use of Visualizations:</p> <p>Client-Facing Visualizations:</p> <p>Use decision trees in visual formats to explain decision points in workflows (e.g., approval processes, percentage-based triggers).</p> <p>Internal Communication:</p> <p>Heat maps are used internally to drill down on data,</p> <p>Opportunities for Improvement:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Purpose and Timing: Visualizations are used to help understand new methods and data availability. Visual aids are employed to ensure consistency and comprehensibility across all audiences. Diagrams, colour codes, symbols, and icons indicate different process steps and variances. Visualizations are often built later in the project to verify accuracy and identify areas needing attention. Examples: Billing Workflow Visualization: The step-by-step process is Use of colours and icons to Consistent visual tools Data Conversion Visualization: Visual validation sheets to compare client data with expert database values. Conclusion: Participants use a mix of detailed discussions, strategy documents, and various visual tools to communicate information to system experts. Visualizations are crucial in conveying complex workflows and ensuring that all stakeholders are aligned, though they are often developed as the project progresses</p>	<p>Integration of Visual Tools: Standardization and Simplicity: Examples: Billing Workflow: Heat Maps and Workflow States: Use heat maps to identify bottlenecks and drill down on specific data points. Conclusion: Participants emphasized the importance of clear, purpose-driven, and simple visualizations for conveying information to system experts. While detailed text-based documentation is crucial for technical communication, visual tools are primarily used for client-facing materials and identifying process bottlenecks. There is a recognized need for better integration of visual tools in internal communications.</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>to ensure accuracy and address discrepancies.</p> <p>Workshops and Forums: Standardization and Cultural Buy-in: A signed-off document Use of Visualizations: Tools and Techniques: Visual aids include PowerPoint presentations, graphs, flow charts, diagrams, and Excel. Standard colours and symbols in workflow diagrams ensure consistency and clarity. Visual tools like Power BI and Purposes: Visualizations help SMEs understand new processes and data, They are used to present findings, get user feedback, and validate the system with developers and SMEs. Cultural buy-in and help focus on Testing to indicate failing and highlight issues. Examples: Process Summaries and Flow Arrows: Validation and Reporting: Conclusion: Participants use a mix of workshops, forums, and visual tools to ensure SMEs agree on the information required for</p>	<p>Workshops and Forums: Facilitation: Decision-Making: Regional Variations: Local Adaptations: Documentation of Decisions: Clarity and Understanding: Black and White: Use of Visualizations: Current Use and Effectiveness: Primary Tools: Software Some Visual Aids: Heat Maps: Effective for displaying 2-3 data points, Standard Charts: Bar charts and stack bar charts are preferred for their simplicity and effectiveness in conveying information. Future Implementation: Acknowledgment of the value of visualizations for effective communication and verification of decisions, indicating an area for growth. Examples and Practices: Billing Workflow: Decision Trees: Workshops Visualization: Software Demonstrations: Conclusion: Workshops and forums are the primary means for SMEs to agree on system configurations and calculations, facilitated by technical or business owner SMEs. While there is some use of visualizations and straightforward and effective tools like heat</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>system configuration and calculations. Visualizations are crucial in facilitating understanding, ensuring consistency, and validating processes, although they are often developed later in the project to address specific needs and discrepancies.</p>	<p>maps and standard charts, the current approach relies more on software demonstrations and text-based documentation. There is potential for improvement in integrating more visual tools to aid the agreement process, enhancing clarity and understanding among stakeholders.</p>
<p>How do you, as an individual, make the new knowledge your own and apply this within the next budgeting and forecasting cycle? What visual cues or tools assist the process?</p>	<p>Testing and Feedback: Simplicity and Iteration: Visual Cues and Tools: Visualization Tools: PowerPoint presentations, Excel spreadsheets, flow diagrams, and waterfalls. Dashboards and colour-coded tiles Specific Visual Aids: Maps of data conversion, data mapping, testing logs, and architectural diagrams of workflows. Graphs, heat maps, and profit and loss heat maps to track variances and highlight achievements. Icons and presentation materials for a consistent visual representation of standard business processes. Advanced Tools: Potential use of automation and AI large data volumes.</p>	<p>Developer Preferences and Consistency: Lack of Formal Process: Knowledge Transition and Client Enablement: Simplicity in Visualization: Visual Cues and Tools: Knowledge Transfer Forums: Two main forums for knowledge transfer: Admin staff passing information to client staff. Client staff gives feedback to admin staff in later stages. Use of Software as Visualization: Large spreadsheets are used for inputting codes and information, but these could benefit from more visualization elements. Documentation and Clear Communication: Current Practices and Room for Improvement: Limited Use of Visualizations: Tools and Visual Cues: Identifies the potential to incorporate more visual aids, especially in large spreadsheets, to enhance visualization elements. Future Trends: AI Integration: Dynamic Information Presentation:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>High-level visualizations of plans or schedules to understand workflows and potential workloads or work buckets.</p> <p>Examples:</p> <p>Controlled Testing and Data Mapping: Project Closure and Internal Reviews:</p> <p>Visual Summaries and Libraries:</p> <p>With icons and other presentation materials to facilitate future implementations.</p> <p>Conclusion:</p> <p>Individuals use a variety of testing, feedback, and visualization tools to make new knowledge their own and apply it in subsequent budgeting and forecasting cycles. Visual cues and tools are integral in communicating, understanding, and refining processes, although the level of standardization varies. Advanced tools like AI and high-level visualizations also aid in managing and analyzing large data volumes, ensuring continuous improvement and effective implementation.</p>	<p>Voice Interaction:</p> <p>Conclusion:</p> <p>While the current process relies heavily on text-based documentation and interactive forums for knowledge transfer, there is recognition of the potential to enhance the use of visualizations. Emphasizing simplicity and consistency in visualizations, along with incorporating more visual aids, can improve the internalization and application of new knowledge in future budgeting and forecasting cycles. The future of visualizations includes potential AI integration, dynamic information presentation, and voice interaction to enhance ease of use and understanding.</p>
Does visualization assist with communication, process, or verification?	<p>Communication:</p> <p>Enhancement of Understanding:</p> <p>Necessity for Workshops: Visual Accessibility</p> <p>Process:</p> <p>Process Representation:</p>	<p>Knowledge Transfer Forums:</p> <p>Two main forums for knowledge transfer:</p> <p>Admin staff passing information to client staff.</p> <p>Client staff gives feedback to admin staff in later stages.</p> <p>Use of Software as Visualization:</p> <p>Documentation and Clear Communication:</p>

Question	Common Themes SMEs	Common Themes SEs
	<p>Focus on Governance: Using Structure Maintenance: Verification: Identifying Issues: Comparison with Expected Outcomes: Less Reliance on Text: Examples and Tools: Workflow Visualization: Easier Visualization: PowerPoint Presentations: Reports and Dashboards: Self-Service Understanding: Processes: Governance Meetings: Focused Discussions: Conclusion: Visualization is a powerful tool that significantly enhances communication, process understanding, and verification. It makes complex information more accessible, aids in representing and understanding processes, and helps identify issues during verification. While detailed text and spreadsheets are still necessary for thorough verification, visualization provides a crucial initial overview and facilitates more effective communication and process management.</p>	<p>Current Practices and Room for Improvement: Limited Use of Visualizations: Tools and Visual Cues: Future Trends: AI Integration: Dynamic Information Presentation: Voice Interaction: Conclusion: While the current process relies heavily on text-based documentation and interactive forums for knowledge transfer, there is recognition of the potential to enhance the use of visualizations. Emphasizing simplicity and consistency in visualizations, along with incorporating more visual aids, can improve the internalization and application of new knowledge in future budgeting and forecasting cycles. The future of visualizations includes potential AI integration, dynamic information presentation, and voice interaction to enhance ease of use and understanding.</p> <p>The respondent's approach to using visualizations in their projects aims to keep their visualizations as simple as possible to ensure stakeholders can easily understand them. They also use visualizations to elicit client requirements rather than dictate workflows. Additionally, they encouraged internal stakeholders to use visualizations to improve communication and verification and to ensure that the knowledge gained from projects is readily accessible to the business. They start with simple visualizations and only add complexity if necessary, avoiding "kitchen sink" approaches that overwhelm stakeholders. They use visualizations to tell a story and highlight</p>

Question	Common Themes SMEs	Common Themes SEs
		<p>important information for different levels of stakeholders. They prefer standard, simple visualizations like stack bar charts over complex or custom visualizations. Heat maps are used effectively as they typically focus on 2-3 data points and allow for drill-down capabilities. The respondent's team encourages co-resourcing and knowledge transfer to enable clients to create visualizations in the future.</p> <p>Their projects primarily use visualizations for communication and verification purposes.</p> <p>Communication:</p> <p>Verification:</p> <p>Process:</p> <p>Sales Process vs</p> <p>Focus on Product Demonstration:</p> <p>Potential for Improvement:</p> <p>Lack of Specific Examples</p> <p>In summary, while visualizations have some role in the sales process, they appear less utilized for communication, process, or verification during actual implementations.</p> <ol style="list-style-type: none"> 1. Crucial for effective communication: <ul style="list-style-type: none"> - 2. Adaptability to different scenarios: 3. Ease of understanding: 4. Consistency in communication: 5. Verification: 6. Process improvement:

Question	Common Themes SMEs	Common Themes SEs
		<p>In summary, the respondents strongly believe that visualizations are valuable tools that assist in communication, can improve processes, and help with verification by ensuring consistent understanding across team members.</p> <p>Simplicity and Accessibility: Purpose-Driven Visualizations: Effective Tools: Heat maps are particularly effective, focusing on 2-3 data points Application in Communication, Process, and Verification: Communication: Verification: Visualizations assist in verification by making it easy to spot issues like outstanding invoices and outliers in accounts receivable. Process Support: Current Use and Potential for Improvement: Sales Process vs. Implementation: Potential for Improvement: Team Dynamics: Crucial for Effective Communication: Adaptability and Ease of Understanding: Verification and Process Improvement: Conclusion: Visualizations play a crucial role in communication, verification, and process support. Keeping visualizations simple and purpose-driven helps ensure they are easily understood and effectively highlight key information. While there is room for improvement in integrating visualizations into implementation processes, their value in enhancing communication and verification is well recognized. The future potential includes</p>

Question	Common Themes SMEs	Common Themes SEs
		broader use in implementation and leveraging dynamic tools like heat maps to improve process efficiency and stakeholder understanding further.
What do you see in the future for visualization?		<p>AI-Generated Commentary:</p> <p>Personalized Insights:</p> <p>Current Limited Use:</p> <p>Increasing Demand and Adoption:</p> <p>Growing Expectations:</p> <p>Tools Like Power BI</p> <p>Mobile Accessibility:</p> <p>Progressive Adoption:</p> <p>Gradual Sophistication:</p> <p>Potential for Growth:</p> <p>Industry Adaptation:</p> <p>Dynamic Information Presentation:</p> <p>Multiple Views:</p> <p>Voice Interaction:</p> <p>Future Development:</p> <p>Focus on Ease of Understanding:</p> <p>Simplifying Complex Data</p> <p>User-Friendly Presentations</p> <p>Challenges in Implementation:</p> <p>Implementation Difficulties:</p> <p>Overall Themes:</p> <p>AI and Personalization:</p> <p>Dynamic and Interactive Tools</p> <p>Mobile and Accessible Visualizations:</p> <p>Gradual Adoption and Growth:</p> <p>Ease of Understanding:</p> <p>Voice Interaction:</p>

Question	Common Themes SMEs	Common Themes SEs
		<p>Implementation Challenges</p> <p>Overall, the future of visualization is seen as increasingly dynamic, interactive, and user-friendly, with significant potential for AI integration and personalized insights. The emphasis will be on making visualizations accessible, understandable, and flexible to meet growing expectations and demands.</p>
<p>Do you think about the proposed budgeting and forecasting system automation using visualization as feedback?</p>		<p>AI Integration:</p> <p>Acknowledgment of Potential: Analyzing historical data to project future trends</p> <p>Interactive Reports: Envisions future reports providing visual data alongside AI-generated written or spoken commentary.</p> <p>Heat Maps:</p> <p>Current Use and Effectiveness: Heat maps effectively visualize 2-3 data points.</p> <p>Application in P&L and Budgeting: Finds heat maps interesting for P&L and budgeting but questions whether people generally understand them.</p> <p>Value in Simplification: Believes heat maps can simplify understanding of budget information by showing what's on or off track.</p> <p>User Understanding and Adoption:</p> <p>Simplicity for Specific Audiences:</p> <p>Straightforward Visuals for Lawyers:</p> <p>Adapting to Audience Needs:</p> <p>Progressive Adoption and Growth Potential:</p> <p>Gradual Introduction:</p> <p>Increased Demand:</p> <p>Growth through Exposure:</p>

Question	Common Themes SMEs	Common Themes SEs
		<p>Current Practices and Challenges: Lack of Out-of-the-Box Solutions: Implementation Difficulty: Transforming Data: Reporting Layer: Separate from Core Tool: Enhanced Understanding Industry Perspective: Industry Maturity: Legal Industry Context: Potential for Improvement: Overall Themes: AI and Interactive Reporting Heat Maps and Simplification: User-Centric Visualizations: Implementation Challenges: The need for out-of-the-box solutions for integrating visualizations into budgeting and forecasting systems suggests data transformation and separate reporting layers. Growth and Industry Adaptation: Anticipates growth in visualization use as users become more familiar with its benefits, particularly in industries like legal that have room for technological advancement. Overall, respondents see significant potential in using visualizations to enhance budgeting and forecasting systems, focusing on AI integration, simplicity, user-centric design, and gradual adoption. Despite current challenges, there is optimism about visualizations' future value and impact in this context.</p>

Table 19: Top 50 Data

DLA Piper	1674	1566	Elite 3E + Intapp	Kira Systems	Kira Systems	Kira Systems + Neota
Clifford Chance	1472	1350	Aderant Expert + Oracle	Logic	Logic	Logic
Allen & Overy	1430	1280	Elite 3E	iManage Work	iManage Work	iManage Work
Linklaters	1378	1267	SAP	Unknown	Unknown	Unknown
Hogan Lovells	1373	1098	Elite 3E	Unknown	Unknown	Unknown
Freshfields Bruckhaus Deringer	1312	1245	Elite 3E SAP HANA - Fulcrum Global Technologies	Unknown	Neota Logic	Neota Logic
Norton Rose Fulbright	1204	1152	Aderant Expert	Unknown	Unknown	Unknown
Herbert Smith Freehills	889	815				
CMS McKenna Nabarro Olswang	840	753	Elite	Unknown	Brainspace	Brainspace
Ashurst	543	586	Elite 3E	Unknown	Unknown	Unknown
Slaughter and May	482	417	Bespoke + Tikit Firmware	Luminance	Luminance	Luminance
Clyde & Co	478	420	Elite 3E	Unknown	Unknown	Unknown
Eversheds Sutherland Intl	427	382	Elite	Unknown	Unknown	Unknown
Pinsent Masons	403	362	Aderant Expert	Unknown	Unknown	Unknown
Gowling WLG	305	172	Aderant Expert	Unknown	Unknown	Unknown
Simmons & Simmons	302	269	Avanade AX Legal (Microsoft Dynamics)	Unknown	Unknown	Unknown
Bird & Bird	288	259	Aderant Expert	Unknown	Unknown	Unknown
Bryan Cave Leighton Paisner	266	259	Elite	iManage	iManage	iManage
Taylor Wessing	261	240	Aderant Expert	Unknown	Unknown	Unknown
Irwin Mitchell	226	203	Elite 3E	Unknown	Unknown	Unknown
DAC Beachcroft	204	199	Elite	Unknown	Unknown	Unknown
DWF	197	194	Elite 3E	Unknown	Unknown	Unknown
Osborne Clarke	194	142	Elite 3E + Intapp	Unknown	Unknown	Unknown

Addleshaw Goddard	193	171	Elite	Kira Systems	Kira Systems	KI
Withers	169	123	Elite	Unknown	Unknown	U
Stephenson Harwood	162	121	Aderant Expert	Unknown	Unknown	U
Macfarlanes	161	140	Elite	Unknown	Unknown	KI
Holman Fenwick Willan	157	144	Elite 3E	Unknown	Unknown	U
Watson Farley & Williams	153	125	Aderant Expert	Unknown	Unknown	Ta
Fieldfisher	153	104	LexisOne	Unknown	Unknown	Ta
Charles Russell Speechlys	141	135	Elite 3E	Unknown	Unknown	U
Mishcon de Reya	139	110	Aderant Expert	Unknown	Unknown	KI
Kennedys	136	129	Elite 3E	Unknown	Unknown	U
Travers Smith	118	97	Aderant Expert	RAVN ACE + Tessian	iManage + Tessian	Ta
Shoosmiths	112	103	SAP	Unknown	Unknown	U
Hill Dickinson	104	112	Aderant Expert	Unknown	Unknown	U
BLM	103	89	Aderant Expert + Elite Envision	Unknown	Unknown	Ta
Womble Bond Dickinson	103	99	Aderant Expert	Unknown	Unknown	KI
RPC	101	94	Aderant Expert	Unknown	Unknown	U
Weightmans	96	100	Elite MatterSphere	Unknown	Unknown	KI
Trowers & Hamlins	92	85	Elite 3E	Unknown	Unknown	U
Mills & Reeve	89	80	Elite 3E	Unknown	Unknown	Ta
Ince & Co	86	87	Elite	Unknown	Unknown	U
Burges Salmon	85	77	Aderant Expert	Unknown	Unknown	Ta
Blake Morgan	74	76	Peppermint Technology LSP	Unknown	Unknown	U
Gateley	74	72	LexisOne	Unknown	Unknown	U
Shakespeare Martineau	72	75	Lexis Axxia + Linetime	Unknown	Unknown	U
TLT	71	58	SOS Connect + Elite Envision	Unknown	Unknown	U
Stewarts Law	70	53	Elite 3E	Unknown	Unknown	U
Freeths	67	56	Aderant Expert	Unknown	Unknown	U
Browne Jacobson	65	59	LexisOne	Unknown	Unknown	U
Brodies	65	58	TR Elite Enterprise	Unknown	Unknown	Ta Lu

Table 20: R Script

```
## Read Data
QSANOVA <- read.csv("chpt10/QSANOVA.csv", header = TRUE)
View(QSANOVA); names(QSANOVA)

## Order the Groups
##QSANOVA$Group <- factor(QSANOVA$Group, levels = c("Niche",
"Leaders", "Unknown"))

mean(QSANOVA$Revenue)

aggregate(QSANOVA$Revenue, list(QSANOVA$Group), FUN=mean,
sd(QSANOVA$Group))

## Figure
boxplot(Revenue ~ Group, data = QSANOVA, main = "(a)")
##
## Analysis of Variance
AOV.1 <- aov(Revenue ~ Group, data = QSANOVA)
summary(AOV.1)

plot(AOV.1$fitted.values, AOV.1$residuals, main = "(b)", xlab = "Group Ave
Revenue", ylab = "Residual")
## Plot reveals unequal spread

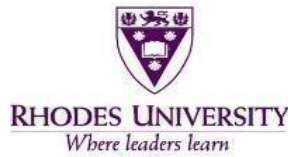
## Levene's test for homogeneity of variance.
library(car)
leveneTest(Concentration ~ Treatment, data = Assignment1_Q1, center =
"mean")
leveneTest(Concentration ~ Treatment, data = Assignment1_Q1, center =
"median")
```

Not in the textbook

Not assuming homogeneity of variance

oneway.test(Revenue ~ Group, data = QSANOVA)

Table 21: Letter Requesting Permission to Conduct Research



ACCESS LETTER REQUESTING PERMISSION TO CONDUCT RESEARCH

Rhodes University
Drostdy Road,
Grahamstown,
6139

Email address of SME/ SE

Date: 05/05/2024

Dear ...,

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a registered PhD student in the Business School at Rhodes University. My supervisors are Prof Noel Pearse and Prof Karen Bradshaw.

The title of my study is Leveraging Visualizations with Systems for Operational and Strategic Decision-Making. We look at how the inclusion of data visualization enhances the capability of technology as a resource for decision-making.

The goal of the study is to clarify the role of visualization:

1. How does visualization aid in sharing expert knowledge.
2. How does visualization aid in knowledge configuration.
3. How does visualization aid in transforming knowledge to agree best practice.

4. How does visualization aid in the storage of knowledge.

We aim to uncover how assumptions are transformed, aiding in configuring and operating budgeting and forecasting systems and ultimately informing decision-making. Utilizing online interviews with subject matter experts, both in configuration and budgeting and forecasting domain experts in legal technology, we will ask the experts questions related to the system configuration and the role of visualization. Themes extracted from these interviews are compared to those in the process model, highlighting visualization's role in assumption improvement and scenario selection. Visualization could be used to summarize complex information for budgeting and forecasting experts, through profit and loss heatmap visualizations comparing prior years data, to enable them to select the best assumption combination, and indicate this with ratings, which in turn trains the LLM for aiding assumption refinement within the related application.

I am hereby seeking your consent to attend an hour-long online session with me which will be recorded. No participant or client name will be mentioned in the research, and all respondents will be referred to with code names. The only specific question relating to this area will be around how many years the respondent has been in the field. To assist you in reaching this decision, I have attached to this letter:

- (a) A copy of an ethical clearance certificate issued by the University.
- (b) A copy of the research instruments which I intend using in my research.

Should you require any further information, please do not hesitate to contact my supervisors or me. Our contact details are as follows:

Prof Noel Pearse at n.pearse@ru.ac.za or Prof Karen Bradshaw at k.bradshaw@ru.ac.za.

Upon completion of the study, I undertake to provide you with feedback, if you indicate in the session that you wish to receive such feedback.

Your permission for me to conduct this study will be greatly appreciated.

Yours sincerely,

Signature:



Name: Carol Cuthbert

Rhodes University, Research Office,
Ethics Ethics Coordinator: [ethics-
committee@ru.ac.za](mailto:ethics-committee@ru.ac.za) t:

+27 (0) 46 603 7727 f: +27 (0) 86 616 7707

Room 220, Main Admin Building, Drostdy Road, Grahamstown,
6139