Faculty 4: Computer Science
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Problems of Ownership in IT

Master's Thesis

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Abstract

The Information Technology (IT) industry has experienced rapid advancements, revolutionizing various aspects of society. However, the surge in the rise of new technologies such as Web 3.0, Internet of Things (IoT), has created a major increase in concerns regarding ownership in the digital sphere. This systematic literature review aims to investigate the complexities and challenges of ownership in the IT industry, focusing on identifying ownership problems, exploring existing ideas for ownership management, and examining the types of assets involved. To achieve this, descriptive statistics were used to summarize the selected articles, while cosine similarity in Python was used to evaluate and extract relevant keywords from the selected studies. Thematic analysis was employed to organize excerpts into themes that describe the challenges, asset types, and ownership management practices implemented. The study indicated data ownership, software, and code ownership, AI-generated content, and digital asset management, characterized by a lack of clarity and ambiguity in ownership rights and responsibilities, and difficulties in establishing and enforcing ownership rights in IT assets as the most significant challenges of ownership in IT. Finally, the study ends with a framework using insight gathered to guide organizations and stakeholders in recognizing potential challenges and effectively implementing ownership management techniques in the sector of study.

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Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Background

The Information Technology (IT) sector comprises of various sub-industries that have major dynamics and characteristics, which includes Application Software, System Software, Internet services, data processing/preprocessing & outsourcing services (GICS, 2023). Information Technology has rapidly developed significantly over the years, constantly bringing novel innovations and technologies that have completely changed society. Beginning with the invention of the first computer and continuing through the creation of Internet of Things (IoT), artificial intelligence and blockchain technology to process information and management of information (Taherdoost, 2023). (Sodring et al., 2020) attributed this trend to the growing volume of tasks and information that are difficult to manage. Organizations can now operate more efficiently and streamline their processes using information technology. IT has also revolutionized how we communicate, access information, and perform transactions, making our lives more convenient and integrated. Nonetheless, the emergence of IT, IoT, and Web 3.0, has significantly raised concerns about ownership in the digital sphere (Aziz, 2023; Janeček, 2018).

Ownership refers to the rights and controls which an individual or entity possessed over an asset. In IT, ownership refers to the ethical rights and responsibilities of individuals and organizations regarding data, technology, software, digital assets, and IT resources (Bird et al., 2011). (Ahlgren et al., 2020a) defined ownership as a concept used to describe the stretch to which an individual accepts responsibility for a particular software element, especially in cases where no identified developer is accountable for the software. In programming, ownership can be referred to as the process of modifying data and tracking aliases, which are useful for memory safety and system architecture (Crichton, 2021). Furthermore, it is regulated by three essential rules: each value has a single owner, references cannot outlast the owner, and a value can have an occurrence of either only one mutable reference or occurrence multiple immutable references.

Ownership in the 3rd stage (Web 3.0) is a basic idea in decentralized systems that allows individuals to control how their data are shared, used, or sold (Chowdhury & Dhawan, 2016). Decentralized technology presents numerous benefits, including increased user protection and privacy as well as greater control over data management and distribution. It gives an individuals with outmost control over who can access their data, sees their data and how the data are being used, resulting in a more transparent and fair digital economy. Internet of Things (IoT) devices facilitate interactions with the environment by enabling mobility and coordination, but the devices generate and collect an enormous quantity of personal data on a scale never seen. Digital devices like the sensors, wearable's, are constantly translating the physical actions into data. Analytic schemes process each click when surfing on the Internet or using social media. Therefore, data management in IoT has resulted in serious ethical and legal concerns (Hummel et al., 2021).

Managing and controlling personal data ownership involves addressing challenges related to trust and security, and it has significant implications for the future of digital data transactions the introduction of data ownership as a legal right has sparked controversy in the EU and beyond (Janeček, 2018). Establishing explicit data ownership rights and enforcing control over data has become more difficult. Ensuring ownership rights while protecting private information is a difficult issue that requires strong security measures and privacy-enhancing technologies (Addagada, 2018). Several studies have consistently shown that the field of information technology faces several types of ownership problems.

Literature Gap

There has been substantial research undertaken to understand the challenge of ownership in the IT sector such as the ambiguity in data ownership and the complexity of intellectual property (IP) rights in software ownership. However, the lack of comprehensive synthesis as a major limitation has impeded this research of the current literature on ownership management in IT, including recent research on Web 3.0, IoT, and IT organization. Research has proposed blockchain technology for managing ownership through digital management systems. However, the existing literature lacks detailed exploration of how different sectors can make use of these ownership management practices within the IT industry. There is a clear distance in understanding how identified entities or asset types can interact and overlap concerning ownership rights.

In summary, the literature on ownership in the IT industry shows different gaps that need to be managed to develop a comprehensive understanding of the subject. While progress has been achieved and ongoing, addressing these literature gaps will lead to more effective management of ownership in the rapidly evolving IT ecosystem.

1.2 Justification of the Research

Addressing ownership problems in IT is crucial due to their significant impact on accountability, knowledge sharing, and code quality enhancement (Koana et al., 2024). Understanding the most suitable owner of a software asset is essential, Has ownership often changes over time, affecting maintenance, evolution, and overall ownership health (Ahlgren et al., 2020a). In software-intensive organizations, asset ownership frequently shifts due to reorganizations and individual role changes, highlighting the need for automated solutions to suggest appropriate owners at any given time (Ahlgren et al., 2020a). Furthermore, the rapid advancement of IT has transformed the landscape of digital asset management (Kirk and Swain, 2018). This study explores the theoretical foundations and practical implications of ownership management, offering a comprehensive understanding of ownership issues within the IT industry. By examining how ownership impacts operations, decision-making, and overall efficiency, this research contributes to the development of improved business processes and the ability of IT firms to adapt to an ever-evolving digital environment. The review consolidates and critically evaluates existing literature on ownership management in the IT industry, identifying gaps and highlighting areas requiring further research. By focusing on studies conducted within this context, this review enriches the body of knowledge on ownership management, providing valuable insights into effective management techniques. The findings aim to guide new businesses and stakeholders in recognizing ownership challenges in the dynamic digital ecosystem and implementing effective ownership management strategies.

1.3 Research Aim and Objectives

1.3.1. Research Aim

This study investigates the complexities and challenges of ownership in the Information Technology (IT) industry, with emphasis on recognizing and analyzing ownership challenges, exploring existing ideas for ownership management, and examining the types of assets leveraging the Systematic Literature Review (SLR) technique. This study aims to establish a complete understanding of IT ownership issues by combining insights from the relevant frameworks.

1.3.2. Research Objectives

Objective 1: To identify the Asset types relevant in the context of ownership in IT.

Objective 2: To identify different ownership management practices in the IT industry.

Objective 3: To identify problems regarding the ownership of data, assets, and ownership health in IT.

1.4 Structure of the Thesis

This study begins by introducing the concept of ownership in information technology, highlighting its expanding importance and the issues associated with ownership in the age of Web 3.0 and the Internet of Things (IoT). This chapter outlines the research objectives, aims, and the overall structure of the thesis. The literature review chapter explores relevant ownership problems in IT, asset types, and techniques for ownership management found in the existing literature while highlighting gaps in the present research. The theoretical framework section then discusses the major concepts and models associated with IT ownership.

The research methodology chapter outlines the study selection criteria, the databases and sources used, and the rationale for using the Systematic Literature Review (SLR) strategy. The results section contains the characteristics of the selected studies as well as the analysis findings. The discussion part goes over the study's results on issues such as ownership management practices, and asset kinds in the IT sector. The conclusion section summarizes the findings, examines their addition to knowledge, identifies their limits, offers topics for further research and advancement, and provides a final word on the study.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter presents a detailed synthesis of the literature and identifies key ownership management practices in Information Technology. The chapter further details the synthesis of different challenges of ownership management in line with the existing strategies and framework in place to provide effective ownership management practices within the IT industry while establishing gaps in the literature and presenting a summary of the chapter. This literature review is essential for this research on ownership in IT, as it consolidates and critically evaluates the current knowledge on ownership management within the IT industry. As ownership plays a critical role in various sub industries, this review specifically focuses on how ownership is demonstrated in IT subsectors such as Application Software, System Software, and Data Processing services. Additionally, this literature review examines how ownership management strategies influence organizational performance and societal outcomes. offering a comprehensive analysis of their implications for IT firms operating in a rapidly evolving digital landscape.

2.2 Evolution of Ownership in IT

Over the years, the term ownership in information technology (IT) has evolved significantly alongside technological advancements. From a historical perspective, ownership in IT is primarily associated with physical hardware components, such as computers and servers (Shirandula, 2015). In the early days of computing, IT ownership was centralized. Organizations own and maintain their hardware, software, and data storage solutions. This period was marked by significant capital investments in mainframes and later on personal computers and on-premises servers (Banterle, 2018). The 1980s and the 1990s marked a significant shift in ownership, as individuals and businesses began owning personal computers and hosting their applications on servers, which clients and users could access remotely. This model paved the way for web-based applications and e-commerce, significantly changing how IT resources are utilized and owned. However, with the advent of software development and the digitalization of data, the notion of ownership has expanded to encompass intangible assets, such as software programs and databases. The shift towards cloud computing and Software as a Service (SaaS) models emerged, revolutionizing the IT ownership landscape by offering scalable and cost-effective solutions through remote servers and virtualized resources. Cloud computing allows organizations to access and utilize software applications and infrastructure without owning physical hardware (Brown & Green, 2020). This shift towards cloud-based services raised questions about the ownership of data stored in the cloud and the responsibilities of cloud service providers in safeguarding user information (Miller & Taylor, 2022). The widespread adoption of mobile devices and the Internet of Things (IoT), a key element of the 4th generation in the IT industry, has significantly redefined the concept of ownership in IT (Brous et al., 2018). As devices and systems, including artificial intelligence (AI), IoT, and autonomous vehicles, become increasingly interconnected, the dynamics of ownership continue to evolve, nanotechnology, and quantum computing, ownership extends beyond individual devices to encompass data flow and networked ecosystems (Raina & Palanisami, 2021). This evolution highlights the complexities of ownership boundaries in a digitally interconnected world. Ownership models have undergone significant shifts from centralized to decentralized, physical to digital, and individual to shared due to advancements in technology and changes in consumer behavior (Gorge & Learney, 2020). Studies have recognized different practices, including blockchain technology (Taherdoost, 2023), as new possibilities for ownership management and how ownership rights are enforced in IT. However, ownership remains a factor that has been shown to significantly influence the use of Information technology (Klesel et al., 2016).

2.3 Problem of Ownership in Information Technology

In information technology, the problem of ownership manifests in various forms. This issue becomes particularly complex when considering data privacy regulations and ethical implications of data ownership in the context of IT systems. This can be traced back to early discussions on copyright protection for computer-generated works, which began with the CONTU commission in 1974 (Banterle, 2018).

2.3.1 Data Ownership and Governance

The emergence of data ownership challenges has led to specific issues in various domains. Data ownership encompasses the intellectual property related to both raw and any derived data (Bormida, 2021). (Prainsack, 2019) (Hummel et al., 2021) highlighted the ethical and social challenges related to data ownership, especially within the realms of big data practices and the Internet of Things (IoT). IoT refers to ‘smart' systems, including electronic, mechanical, and biological devices, with onboard sensing, computing, actuation, and communication capabilities to share real-time information and the Internet (Ajay Raina & M. Palaniswami, 2021). (Mashhadi et al., 2014a) discuss in their study, the emergence of machine-to-machine communication, often classified under "Smart City" initiatives, characterized by the vast amounts of data it generates. The generated data provide a detailed insights about the user characteristics of the devices used, and if properly channeled and extracted, can reveal a lot about an individual that may compromise the individual's privacy. Meanwhile, (Ajay Raina & M. Palaniswami, 2021), research on IoT products highlights the challenge of private ownership in the new revolutionary era. The product's nature fragments ownership, with the vendor maintaining jurisdiction even after the market exchange. As IoT penetration deepens, ownership seems to slip away from the owner, challenging the traditional conceptions of private property, personal autonomy, and political economy. This gives rise to the entire data ownership and privacy problems. Owing to these privacy and confidentiality concerns, cloud data owners prefer to encrypt data using their keys before outsourcing them to the cloud (Jiang et al., 2020). Data de-duplication techniques, which identify and eliminate duplicate data at the file or block level to minimize storage space by retaining only a single copy on a cloud server, can be exploited as a side-channel attack, leading to potential data leakage in cloud storage. The increasing power differential between corporations and individuals, whose data are used, underscores the need for robust data governance frameworks. (Bloor, 2020b; Cai et al., 2023) discussed how current data ownership models, characterized by centralized control, raise concerns about privacy and user autonomy. Real-world examples like data privacy breaches, unauthorized sharing of personal data by social media platforms without user consent, unauthorized data scraping, and intellectual property disputes highlight these complexities.

2.3.2 Software and Code Ownership

In the field of software ownership, distinct challenges have arisen due to the evolving nature of ownership assignment and the intricacies of intellectual property rights. For example,, determining the most suitable owner for a software asset can be challenging as ownership needs change over time within software-intensive organizations (Ahlgren et al., 2020a). Real-world examples of these challenges include cases where a professor creates a database with copyright entitlement while their employer, the University, invests substantially in it, leading to ownership disputes and questions on exploitation rights (Sousa E Silva, 2014). (Greiler et al., 2015) defines code ownership as the number of engineers who have contributed to a certain source code artifacts, as well as the fraction of their efforts. This determines the collaboration networks between the software engineers working on the project. (Bird et al., 2011; Zabardast et al., 2022b) revealed in their studies that there is a relationship between ownership measures and software quality. The scarcity of ownership is possibly going to cause absence of responsibility for the parts of code that an engineer does not posses, thereby limiting the functionality and inner workings of the code. (Orru and Marchesi 2016) defined code ownership as the ratio of the number of commits made by individual developers (NCD) to the total number of commits (TCD) made to a particular code artifact. Additionally, Bird et al. (2011) conducted a case study on Windows Vista and Windows 7, revealing that Windows binaries with sparse ownership—where numerous developers contribute minimal amounts of code—exhibit this phenomenon, are often possibly to be defect-prone than vehemently owned Windows binaries. (Greiler et al., 2015) in their studies widened the set of investigation into Microsoft four main products which are Office, Windows, Office365, and Exchange. They showed that the reduction in ownership metrics can be correlated with the number of defects that are fixed.

2.3.3 Ownership of AI-Generated Outputs

Specific ownership problems that have emerged in areas like AI-generated output include issues related to intellectual property rights and data ownership. This perspective raises questions about the status of AI as an inventor and its implications for patentability and ownership rights. This is consistent with the findings of Aziz (2023) examined whether works generated by AI could be considered original and worthy of copyright protection. For instance, on October 25, 2019, an image created by a generative adversarial network (GAN) was auctioned at Christie's for $432,500., raising concerns about who should hold the copyright to the artwork (Epstein et al., 2020). These studies raises concerns over the need for an effectual definition of authorship that includes all stakeholders involved in creating the AI system. While (Banterle, 2018) that ownership of AI-generated inventions should default to the programmer.

2.3.4 Digital Asset Management

The digital art market faces unique ownership challenges, including the establishment of norms for collecting and attributing digital works. (McConaghy et al., 2017a) discussed the difficulties in defining ownership and authenticity in digital art, the problem is worsened by the simplicity of copying and distributing digital files. Kirk and Swain (2013) highlight in their research that, despite the intangible nature of digital technologies, consumers often experience a sense of psychological ownership over these technologies.. However, (Prainsack, 2019) argued that due to the e of the abundance of digital data and information, we cannot just presume that digital commons functions like physical resources to the digital commons, Instead, it is crucial to explicitly consider the processes, categories, and impacts of exclusion from digital data and information commons as a foundational step in developing appropriate principles for managing these digital resources.

2.4 Different Types of Assets in IT

An analysis of the selected literature revealed diverse asset types, each contributing uniquely to technological advancements and organizational value. From artificial entities in application software to data quality services in system software, these assets drive innovation and efficiency in the IT industry. These assets were further categorized into six types, as discussed below.

2.4.1 Artificial Intelligence Entity

This subsector includes Artificial Entities that represent a significant step towards autonomous systems capable of performing complex tasks. Artificial entities include advanced cognitive robots designed to mimic human cognition and decision-making processes, showing sophisticated software architectures and AI capabilities. (Aziz, 2023; Banterle, 2018) discussed these entities in the context of enhancing operational efficiency and decision accuracy, highlighting the integration of AI in everyday applications.

2.4.2 Data Assets

Data assets are pivotal in the domain of application software and primarily focus on big data analysis. These assets include diverse data properties and types, such as text, images, audio, and video, which are crucial for deriving valuable insights for business operations and strategic decisions. (Bormida, 2021) emphasized the role of these data assets in enabling comprehensive big data analysis, while (Berti Suman et al., 2020) discussed their importance in ensuring data accuracy and reliability in various applications. Data-processing devices, designed for transforming raw data into actionable insights, play a vital role in optimizing business processes (Osborne et al., 2018).

2.4.3 Software Assets

Software assets in system software are fundamental for the development and maintenance of high-quality software systems. Code quality is a crucial aspect that involves the assessment and improvement of source code to ensure reliability and performance. (Bird et al., 2011; Greiler et al., 2015; Nero, 2021; Thongtanunam et al., 2016; Zabardast et al., 2022b) provided insights into various approaches to enhancing the code quality of software artifacts, such as larger code components, files, and tables in data warehouses, which are essential for software development and maintenance. Orru & (Ahlgren et al., 2020a; Orru & Marchesi, 2016) discussed the significance of managing these artifacts to ensure efficient software life cycle management. Software assets can also be in the form of smart contracts; for instance, representing mechanized contracts with terms that are rightly encoded into software, primarily used on blockchain platforms. (Michael Coblenz et al., 2020) points out the possibilities of smart contracts to automate transactions and reduce the need for intermediaries. Another significant software asset as discussed by (Will Crichton, 2020) is the Rust programming language designed to enable everyone to create reliable and efficient software and is known for its unique ownership model enforced by the borrower checker.

2.4.4. Internet of Things (IoT) Assets

IoT assets are characterized by their ability to connect and interact seamlessly in smart environments. These assets include self-adaptive architectures that adjust to dynamic conditions, thereby enhancing the efficiency and reliability of IoT deployments, as highlighted by (Alfonso et al., 2021a). Smart city devices, such as vehicles and homes, are crucial in the development of smart cities, integrating various IoT technologies to create interconnected and intelligent urban environments. (Chowdhury & Dhawan, 2016) emphasized the transformative potential of these devices in enhancing urban living standards. Moreover, self-contained and infrastructure connected objects facilitate seamless communication and interaction in IoT ecosystems, as discussed by (Mashhadi et al., 2014a). IoT assets also include various IoT-enabled products and devices, which are integral to smart-city applications and other IoT deployments. (Ajay Raina & M. Palaniswami, 2021; Romdhani, 2017; Sodring et al., 2020) highlighted the importance of these assets in creating interconnected and intelligent environments.

2.4.5 Corporate Assets

Corporate assets within tech firms are integral to enhancing firm value and achieving strategic objectives. Studies by (Basu et al., 2020; Boyd & Solarino, 2016; Lakmal, 2014) emphasized the importance of corporate governance and ownership models in driving firm value. These assets encompass various dimensions, including product-service systems, which integrate products and services to deliver comprehensive solutions. (Cherry & Pidgeon, 2018) highlight the evolving nature of these systems in response to market demands and customer needs. Corporate assets involve data and processes that ensure an efficient service delivery.

2.4.6 Digital Assets

Digital assets cover a broad spectrum of digital intellectual property. These assets include designs for objects, broadcasts, logos, videos, trademarks, chemical formulas, and other forms of digital properties, as described by (Das, 2011). (Cai et al., 2023) discussed the importance of managing social data to enhance user engagement and privacy. Social data, which is fundamental to social media platforms and online interactions, represents a key digital asset. The concept of a digital ecosystem, encompassing all digital content and services, is crucial for fostering innovation and collaboration, as highlighted by According to (Góngora, 2014), the concept of a digital ecosystem, which includes all digital material and services, is critical for supporting creativity and cooperation. Digital material, such as music, books, and websites, is vital to the digital media. (C. P. Kirk & Swain, 2018) emphasized the role of digital content in shaping consumer experiences and driving industry growth. Data from telecommunication companies represent another significant digital asset, essential for network management and service delivery, as highlighted by (Šupica & Pavić, 2012). (Gohi & Bujad, 2022; McConaghy et al., 2017b) discussed the critical role of managing digital assets to ensure data privacy and security.

2.4.7 Cloud Services

Cloud services on the Internet involve data storage solutions that offer scalable and secure data management options. (Jiang et al., 2020; Mangalam College of Engineering & Radhakrishnan, 2019) emphasized the importance of cloud data storage in enabling flexible and efficient data handling for organizations of all sizes. Cloud services in system software manage data related to manufacturing processes, maintenance services, and spare parts inventories. (Razmi-Farooji et al., 2019) emphasized the role of cloud services in optimizing industrial operations. Databases are also fundamental for storing and managing large volumes of data and ensuring data availability and integrity, as discussed by (Chaudhuri et al., 2011).

2.5 Ownership Management Practices in Information Technology

Ownership management practices in IT encompass several techniques designed to ensure proper governance and preservation of technology-based assets. Researchers have examined various facets of ownership management, focusing on how companies manage the intricacies of digital ownership in an increasingly networked and data-driven world. This section explores the existing body of knowledge on ownership management techniques in IT, emphasizing the many approaches and the best practices suggested by scholars. Analyzing these practices allows us to obtain insights into the issues and opportunities connected with managing ownership in the IT industry, facilitating the development of more effective and fair ownership management frameworks.

2.5.1 AI and Computational Inventions

(Banterle, 2018) proposed interpretative solutions to align patent systems with the development of computational inventions. The challenge lies in the traditional patent frameworks, which often struggle to accommodate the unique characteristics of AI and computational inventions. By adopting a more flexible and interpretative approach, it becomes possible to provide adequate protection and incentives for innovation in the rapidly evolving field of AI. (Aziz, 2023) suggests a hybrid ownership model that grants legal status to artificial intelligence systems, along with their programmers, users, and related companies, under a legal entity known as Artificial Personality (AiLE). This model aims to address the complexities of assigning ownership and responsibility in AI-driven innovations, ensuring that all stakeholders are legally recognized and accountable.

2.5.2 Data Governance Models and User-Centric Approaches

(Berti Suman et al., 2020) provided analytical constructs for data governance models informed by social science, emphasizing the need for robust frameworks to manage data effectively. (Bormida, 2021) advocated for a data acquisition approach that is centered around user and control, empowering users with total ownership over their data. This approach includes developing technologies that allow the users to collect, store, update, and also share personal data while maintaining data sovereignty and security. (Chowdhury & Dhawan, 2016; Mashhadi et al., 2014b) explored various data ownership models, including unrestricted, semi-restricted, license-restricted, pay-per-usage, and fully restricted models on smart city devices. The unrestricted data model addresses the data sharing of devices containing wide-ranging information, in the semi-restricted data model the owner can decide to share generalist information with the device manufacturer or any other body or individual that deems to use this information as feedback for evaluating and enhancing the performance of the device. License restricted data model defines the setting that will be dependent on the user whether he wants to share his data and there will be a license that will define different ways in which his data is to be shared, the fully restricted data model generally concerns devices which have vulnerable information stored within them while Pay per Usage was a popular choice of model among vendors or people who would generally purchase devices for public use and generate remuneration from a pay per usage kind of a model. (Cherry & Pidgeon, 2018) explored the concept of pay-per-use Product-Service Systems (PSS) highlights that ownership dynamics significantly influence this model, suggesting that pay-per-use service provision necessitates adopting a distinct set of business models for effective implementation for a successful transition. (Greiler et al., 2015; Thongtanunam et al., 2016) recommended human resources intervention for ensuring code quality as best practices in code ownership and software development. (Bormida, 2021) utilized the findings of his research to address the issue of data ownership: whether it belongs to the user, the company that performed the analyses, or the organizations that gathered the original data. He emphasized that this issue should be tackled not only through national and European IPR legislation regarding data, which remains unclear, but also by engaging in discussions on data ethics. Developing best practices, recommendations, and guidelines for data collection would provide significant value. In B2B data sharing, there must be a careful balance between the interests of data producers in maintaining control and ownership, the public's need to prevent data monopolies, and the rights of individuals whose personal information is collected by companies. A new automation tool used at Facebook 'Ownesty System' serves as an example of making use of both data mining and machine learning to determine the best owner for assets. This ownesty system recommends new ownership and validates ownership health (Ahlgren et al., 2020a)

2.5.3 Ownership Practices in the IoT System

(Alfonso et al., 2021b) classified dynamic events impacting Quality of Service (QoS) and proposed self-adaptation strategies for IoT systems. These strategies include data flow reconfiguration and offloading tasks to cloud servers for critical processing, ensuring low response latency and efficient system performance. The study also highlights the importance of software deployment and upgrade strategies for continuous system improvement. While (Sodring et al., 2020) illustrated how Generally Accepted Record-keeping Principles (GARP)—which encompass Accountability, Transparency, Integrity, Protection, Availability, Compliance, Retention, and Disposition—are employed to address challenges in managing IoT data. Among these principles, the Protection principle strongly supports a centralized approach to IoT data management.(Ajay Raina & M. Palaniswami, 2021) discussed that if we are to retain the substantive content of private property and ownership, then the distribution of ownership rights in the IoT space needs to be structured and clarified in public policy. This principle implies that the owner's right to control the usage of an IoT item should be safeguarded in the same way as it is for non-IoT products. The vendor must retain some control over the product's use, but only if it is compatible with maximizing the owner's utility as they see it, and with the owner's agreement. Given the current technology context, control should be considered as a residual or delegated right, not as the vendor's natural right. Legally, the vendor's control should be defined at the time of sale (Ajay Raina & M. Palaniswami, 2021).

2.5.4 Data Protection Using Blockchain Technology

Blockchain is becoming increasingly important in securing digital identities and data (Bloor, 2020b). Blockchain technology has appeared as a possible solution for improving copyright protection and ensuring transparency in the dissemination of digital information. (Cai et al., 2023) presented Social Chain, a decentralized blockchain-based system for storing and transmitting social information. This technology restores data ownership to consumers while delivering secure and effective data management solutions. In line with these practices, (Bormida, 2021) highlights technologies such as sticky policies, blockchain, distributed ledger technologies, smart contracts, digital rights management systems, and APIs are emphasized as solutions for ensuring data exclusivity. These tools offer flexible and pragmatic approaches that combine agile contracting with advanced technology to achieve greater certainty and predictability. The technology layer provides enabling technologies for implementing and enforcing the terms and circumstances of data-sharing agreements.

2.6 Relevant Theoretical Frameworks Related to Ownership in IT

Ownership in IT has an extended theoretical and empirical literature. Different approaches were developed to completely understand the IT ownership management model. The four theories presented in this study are the most recognized and cited in Ownership in IT studies. Each theory's different points of view complement each other and bring excellent frameworks to analyze ownership in IT and each aspect that influences its adoption as a management model.

2.6.1 Legal Framework

The concept of ownership is a complex and evolving issue within legal theory (Farkas, 2017). For physical objects such as property and vehicles, ownership laws are well-established and uniform globally. However, from a data protection perspective, the legal rights of businesses that exploit personal data remain contentious (Bloor, 2020a; Bormida, 2021). The idea of data ownership has gained traction only in recent years, resulting in diverse legal approaches across different countries. The prevailing perspective in various jurisdictions holds that data ownership is not recognized. This stance is supported by legal precedents in countries like the United States and the United Kingdom., where property rights are not granted to mere facts or information. While some commentators in the US have shown openness to data ownership, national legal frameworks vary in their approach to this issue (Hummel et al., 2021). The European Union (EU) was a pioneer in addressing data ownership by implementing the General Data Protection Regulation (GDPR).. GDPR implements a control approach whereby it gives data owners more rights to govern their data (Prainsack, 2019). The GDPR grants individuals particular rights, including the right to request the deletion of their data (referred to as the 'right to be forgotten') and the right to transfer their data to a different service.. These rights allow individuals to request that their data be deleted and transferred between controllers, respectively (Boerding et al., 2018). These rights also aim to enhance personal control over data and ensure its protection (Hummel et al., 2021). GDPR applies to any firm that handles EU citizens' data, and it imposes hefty fines for noncompliance. As a result, many significant firms globally have implemented GDPR-compliant procedures, which may influence similar legislation in other countries.

Another primary source of EU law and the European Convention on Human Rights (ECHR) emphasize safeguarding privacy and personal freedom, linking informational self-determination to these essential rights. Although the ECHR does not explicitly protect personal data, it sets the groundwork for data protection laws that establish preconditions for data handling (Boerding et al., 2018). Furthermore, the European Data Protection Supervisor (EDPS) acknowledged that maintaining human dignity is intricately connected to respecting privacy rights and safeguarding personal data (Bormida, 2021).

In the United States, there are various initiatives favoring data ownership, reflecting bipartisan support. Senator John Kennedy, for example, introduced legislation to protect social media data privacy, while former presidential candidate Andrew Yang promoted data ownership during his campaign (Hummel et al., 2021). In 2020, the United States enacted the California Consumer Privacy Act (CCPA), marking a significant move toward regulating the use of data belonging to Californians and drawing comparisons to the GDPR (Chen & Chen, 2023). As additional states consider similar legislation, the legal landscape in the US is evolving.

Overall, the legal framework for data ownership in IT is subject to continual discussions and developments. The evolving nature of these laws reflects the broader challenges of integrating data ownership into existing property law frameworks and ensuring effective management of data resources.

2.6.2 Psychological Ownership Theory

Psychological ownership describes the sense of personal attachment and recognition that an individual feels towards an object, whether it is physical or abstract. This sense of ownership is marked by an emotional connection and personal identification with the object (Morewedge et al., 2021). The emotional investment and psychological ownership that individuals develop towards digital assets, software, and information systems can profoundly influence how they interact with and assign value to these technologies. (Morewedge et al., 2021) noted that consumers often cultivate psychological ownership sentiments towards products and concepts even without legal rights, such as beloved brands or digital content while displaying reduced attachment to legally owned items like stocks. (Gaskin & Lyytinen, 2010) in their research found that psychological ownership affects performance and individual outcomes, primarily driven by internal factors. This highlights the highly subjective and personal nature of psychological ownership, which extends beyond mere legal ownership or rights.

Psychological ownership theory offers a valuable perspective on the personal sense of ownership individuals develop towards various entities, including objects, ideas, IT systems, and digital assets, even without legal ownership. This concept is particularly relevant in the realm of information technology, where it significantly influences user interaction and perception. Researchers have used psychological ownership as a framework to explore how individuals appropriate technology, expecting that those who do so will experience personal satisfaction and a sense of connection to the technology as they become more familiar and skilled with its use (Gaskin

& Lyytinen, 2010).. In the digital technology context, psychological ownership theory suggests that specific attributes of digital assets, such as their perceived value, personalization, and control, are crucial for users to establish feelings of ownership. Users tend to experience a heightened sense of psychological ownership for digital assets when they have the ability to personalize, alter, or control them, as these elements enhance their personal connection and investment in the asset. According to Klesel et al. (2016), this concept builds on Barki et al.'s definition of psychological ownership of IT (POIT), which refers to the sense of ownership an individual feels towards an IT system or application. Furthermore, (Klesel et al., 2016) enhanced the understanding of psychological ownership of IT by identifying new antecedents such as technology appreciation, freedom of choice, and surveillance. These factors influence perceptions of IT ownership, highlighting the dynamic nature of psychological ownership in the digital age.

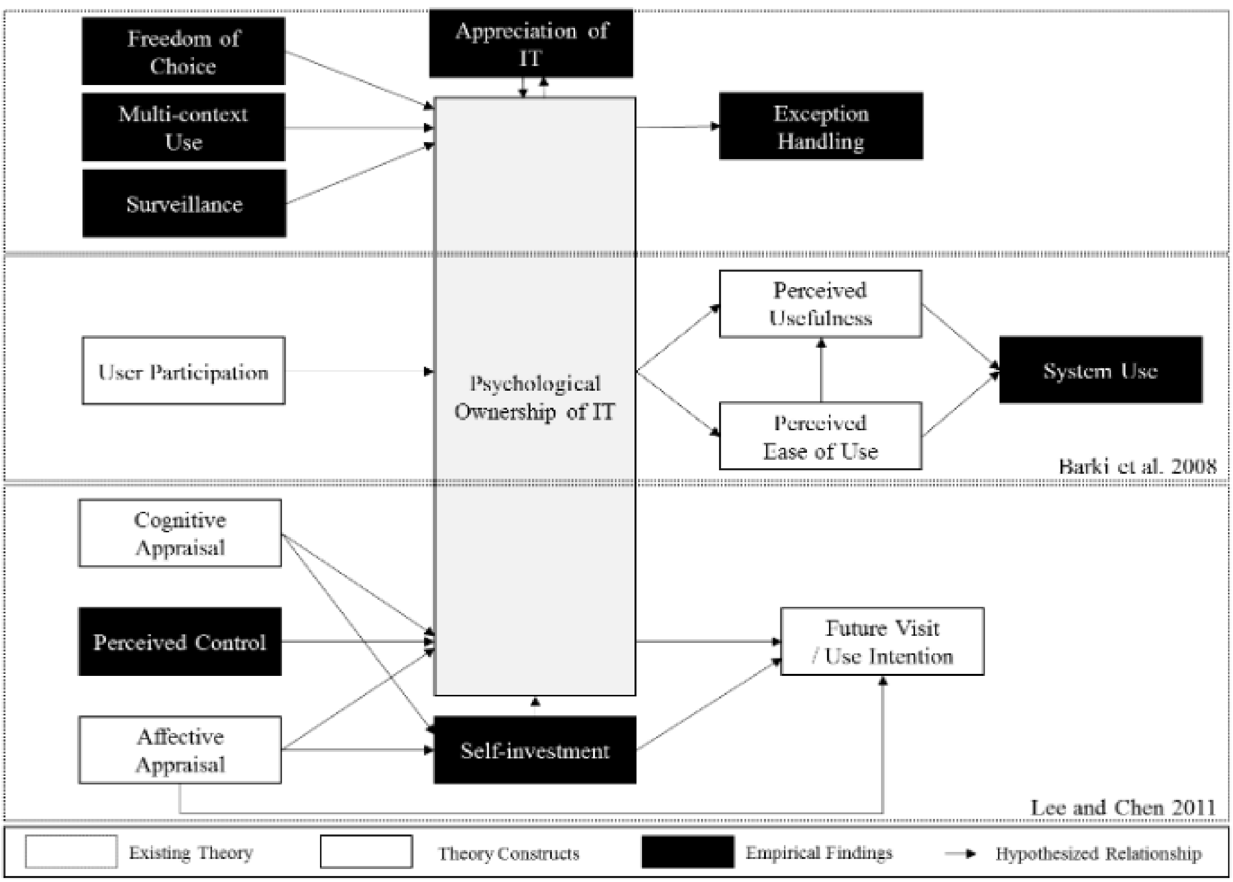

Figure 1: Psychological Ownership of IT (adapted from (Klesel et al., 2016, p. 3))

Understanding the concept of psychological ownership in IT will assist firms in creating more engaging and user-friendly solutions. Companies that cultivate a sense of ownership can improve user satisfaction, loyalty, and overall value perception. Integrating psychological ownership theory into information systems research can provide deeper insights into user behavior, resulting in more effective and tailored IT solutions (Klesel et al., 2016).

2.6.3 Intellectual Property Rights (IPR)

Intellectual property encompasses the legal rights that individuals and organizations have over their creative works, such as patents, copyrights, and trademarks. These safeguards are critical for determining ownership in the context of information technology. These rights protect original works and incentivize innovation (Manasi et al., 2023). Intellectual Property Rights theory in the field of IT addresses complex issues related to computational creativity, where AI systems autonomously generate outputs that qualify for IP protection, such as inventions, artworks, and datasets (Banterle, 2018). Furthermore, the digital age has led to numerous debates and conversations about copyright protection on the internet. As digital content becomes more widespread, the necessity for strong Intellectual Property Rights measures to secure online works and prohibit unlawful use grows more critical (McConaghy et al., 2017).

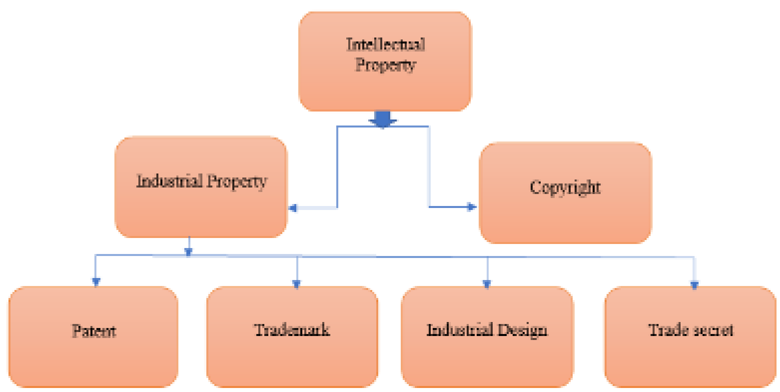

Figure 2: Types of intellectual property (adapted from (Manasi et al., 2023, p. 157))

The article 27 from the Universal Declaration of Human Rights establishes people's universal right to have their moral and material interests protected in connection to whatever scientific, literary, or creative contributions they generate (Manasi et al., 2023). The World Intellectual Property Office (WIPO), a United Nations organization, oversees international copyright agreements and establishes standards for intellectual property rights (McConaghy et al., 2017b). This comprehensive legal structure protects numerous aspects of intellectual property, allowing innovators to control and profit from their ideas. For example, the Indian government has enacted policies granting intellectual property rights, crucial for IT companies to protect their advancements, generate revenue, secure funding, and enhance their expansion prospects (Manasi et al., 2023; Purohit & Ghai, 2023). Additionally, intellectual property rights significantly contribute to fostering innovation and competition within the IT industry by motivating companies to continuously develop new technologies and solutions to maintain a competitive edge.. The rapid expansion of the Indian IT industry underscores the importance of Intellectual Property Rights in upholding a competitive advantage and driving economic progress. Through safeguarding innovations, patents, and copyrights, Intellectual Property Rights empower IT firms to leverage their breakthroughs and prevent unauthorized utilization of their ideas.

IPR theory is fundamental to the IT sector, providing the essential legal structure to safeguard and monetize innovations. It fosters an atmosphere that encourages ongoing innovation and investment, allowing IT businesses to thrive in a competitive global market. The constant technological progress, particularly with the emergence of AI, continues to influence and test the application of IPR, necessitating ongoing legal and regulatory changes to handle new and emerging challenges.

2.6.4 Property Rights Theory

Property rights are the legal or moral rights that an individual or entity holds over a specific asset or property. According to the theoretical foundation of property rights, these rights are defined as individuals' rights to utilize resources, upheld by social norms, customs, ostracism, and formal laws that are enforced through state authority, including coercive measures or penalties (Prince Michael Von & Liechtenstein, 2018).. These rights empower the owner to make decisions about the asset, such as its use, distribution, and modification. Ownership control entails the power and authority wielded by the owner over the asset. In today's postmodern information society, the evolution of data into a critical asset emphasizes the necessity of a foundational property law approach to tackle data ownership (Prince Michael Von & Liechtenstein, 2018).

Property rights are essential in IT asset management, offering a structured framework for owning, safeguarding, and utilizing intellectual assets (Webster et al., 2015). Property rights theory will help in analyzing resource rights sets, assigning them to different individuals, and establishing rights bundles that meet specific data features (Martina Eckardt & Wolfgang Kerber, 2024).

This theoretical framework supports the efficient management of IT resources, establishing a basis for the legal and practical aspects of ownership crucial in the digital era. Understanding property rights theory is key to navigating the complexities of IT ownership and maintaining a balance between safeguarding and accessing IT assets.

2.7 Concepts of Ownership in IT

Data Ownership: Data ownership refers to the legal and ethical rights, as well as the controls, that persons or organizations have over the data they create or obtain. It involves establishing who has the rights to access, use, alter, and remove data. This typically includes identifying the authority for accessing, utilizing, modifying, and deleting data. Two primary models of data ownership are frequently debated:

- Private Ownership: This model asserts that individuals or organizations have exclusive rights and control over their data. It emphasizes individual control, privacy, and property rights.
- Public Ownership: This model stated that individual-level health data should be maintained as a public or common good. It emphasizes collective benefits, free access, and the public interest.

Traditional property laws are being reevaluated in the digital economy, where questions arise about establishing ownership over easily replicable digital artifacts and dynamically evolving data assets. (Boerding et al., 2018) discusses the significant of clarifying how data can be assigned to a legal entity, emphasizing criteria involving information, technology, and economics. It also delves into defining the boundaries of data ownership rights, which include both positive powers and negative protections. The concept of data ownership is noted to have limitations in balancing conflicting rights like intellectual property and privacy, ensuring proper safeguarding of sensitive data.

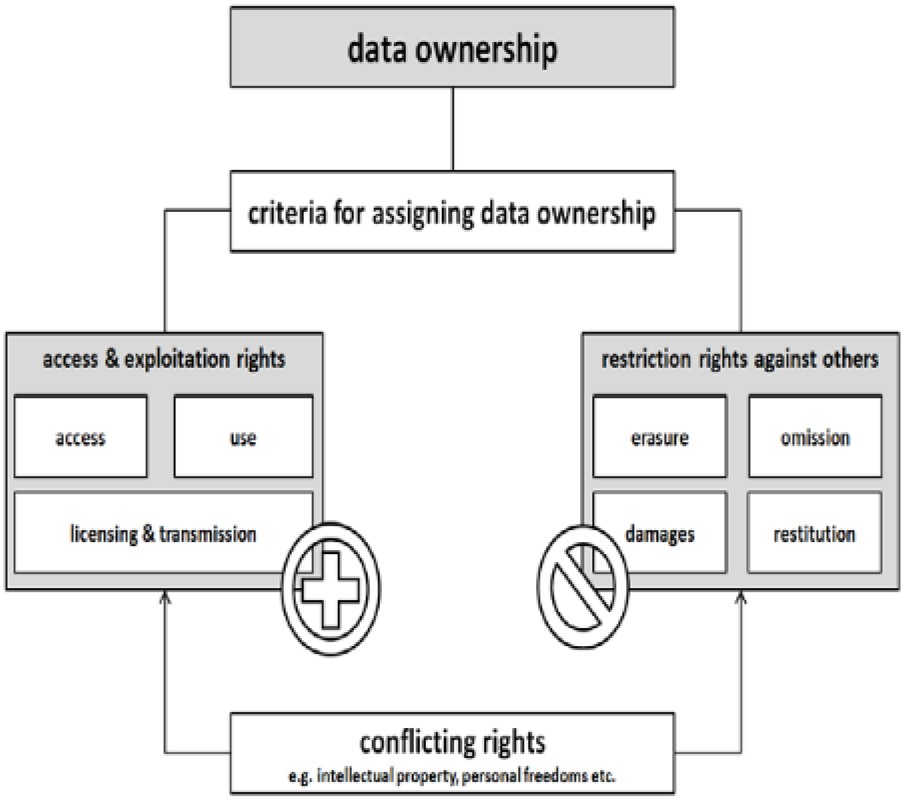

Figure 3: Data Ownership structure (adapted from (Boerding et al., p. 11))

Ownership Health: Ownership health refers to the well-being and ethical considerations associated with data ownership. It involves analyzing the impact of data ownership on individuals, communities, and society (Hummel et al., 2021). In Information Technology, Ownership health refers to the process of determining the most suitable owner for various software assets within organizations, which can change over time due to reorganization and functional shifts (Ahlgren et al., 2020a). Ownership health also considers the risks and vulnerabilities associated with data ownership, including data breaches, unauthorized access, and misuse (Hummel et al., 2021). Ownership health gives rise to interesting research problems and challenges.

Ownership Transferability: The idea of ownership transfer is a process in IT that involves passing responsibility and control over IT assets or data, such as software, hardware, data, and digital content, from one business or individual to another. This transfer of ownership is critical for the proper administration and governance of IT resources since it represents the transfer of rights, access privileges, and decision-making authority over digital assets. When an asset is mapped to a new owner, then this may be referred to as an ownership transfer (Ahlgren et al., 2020a). Therefore, organizations and individuals need to understand the level of ownership transferability associated with their IT assets.

Ownership Governance: Data governance is a component of IT that specifies data ownership, accountability, and management throughout its entire existence. This involves developing detailed guidelines for data collection, storage, use, and sharing to ensure its accuracy, consistency, and security. Data governance systems often include policies, standards, quality controls, access restrictions, privacy protections, and security protocols (Hummel et al., 2021). By implementing effective data governance policies, firms can improve data quality, maintain regulatory compliance, and better exploit their data to create business success (Berti Suman et al., 2020).

2.8 Key Terms

To facilitate discussions on ownership in IT, it is important to familiarize oneself with key terms:

1. Tangible assets include IT hardware, servers, and other equipment.
2. Intangible assets include software, databases, and digital information.
3. Copyrights grant legal protection for original works of authorship, such as software, digital content, and multimedia.
4. The General Data Protection Regulation (GDPR) is an EU regulation that oversees data protection and privacy.
5. Patent is the legal rights granted to Inventors to their inventions for a set time.
6. Trademarks are symbols, names, and logos used to identify and differentiate products or services.
7. Trade Secrets are referred to as confidential company information that gives a competitive advantage, safeguarded by non-disclosure agreements and legal means.
8. Digital IDs are biometric or digital identity methods for accessing and managing IT resources.
9. Cloud computing refers to Internet-based services that share processing resources and data with computers and other devices on demand, creating concerns about data ownership and management.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The research methodology section is crucial as it outlines the techniques and methods employed to gather and analyze data. This chapter describes the specific process employed to conduct the research. It begins by justifying the chosen research approach, followed by a full discussion of the research tools that were used. A discussion on the data extraction process from the selected studies concludes the chapter.

This chapter offers an in-depth look into the research design and the specific methods employed to address the research questions. It details the approaches and tools utilized in formulating the research questions, establish the search strategy, set inclusion and exclusion criteria, select relevant databases and literature, export the search results, screen the results, assess the findings, and extract and synthesize the results to achieve the research objectives.

3.2 Justification of the Research Methodology

This study conducted a systematic literature review using a qualitative methodology to comprehensively explore ownership issues within the IT field. Qualitative systematic reviews, as outlined by Rao et al. (2017), employ explicit and detailed methods to systematically identify, choose, and evaluate the quality of individual studies and the overall body of evidence. Given the intricate nature of the information technology domain, the adoption of a systematic literature review (SLR) has emerged as the most suitable method to comprehensively synthesize the existing literature on ownership management in IT. This approach and unbiased assessment will assist in exploring what is already known about the subject, assembling crucial information and gaining a comprehensive understanding of the complexities within the Information Technology field.

The systematic literature review meticulously surveyed the existing literature, journals, books, and systems related to ownership complexities in IT. This approach not only evaluated the methods employed in these systems but also critically assessed their strengths and weaknesses, thereby identifying gaps in current approaches. The overarching goal is to propose solutions to promote fair and effective ownership management in the IT industry to address the identified gaps and capitalize on the strengths identified in the existing literature.

To ensure thoroughness and reliability, the review followed a systematic approach adhering to the predetermined methodology outlined in Figure 2. The review reporting adheres to the guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Sodergren et al., 2015).

3.3 Research Design and Methods

3.3.1 Research Objectives

The objective of this systematic review is to conduct an in-depth examination of the challenges related to ownership of data, assets, and ownership health in the domains of Information Technology (IT), Internet of Things (IoT), and software organizations. While existing literature reviews on IoT have predominantly concentrated on particular sub-domains, including smart cities, cyber-physical systems, and industrial IoT applications (Alfonso et al., 2021a), This research seeks a holistic examination encompassing IT, IoT, and Organizations. The intent is to identify, analyze, and understand critical issues related to data, files, repositories, and codes and to explore the legal entitlements and authority held by individuals or entities over these IT assets. Additionally, this study seeks to explore and assess the effects of ownership implications on organizations and society, and to propose solutions for fostering equitable and efficient ownership through novel software solutions and automation, as recommended by Ahlgren et al. (2020b) in the IT sector.

3.3.2 Research Questions

Based on the objectives in the preceding chapter, the study addresses the following three research questions.

- RQ1. What asset types are relevant in the context of ownership?
- RQ2. What ideas for ownership management (assignment) exist in the IT industry?
- RQ3. What problems or challenges related to "ownership" exist in the IT industry?

3.3.3 Research Tools

This section outlines the tools used to address the research questions and meet the study's objectives. Further details about these tools will be provided in the following section.

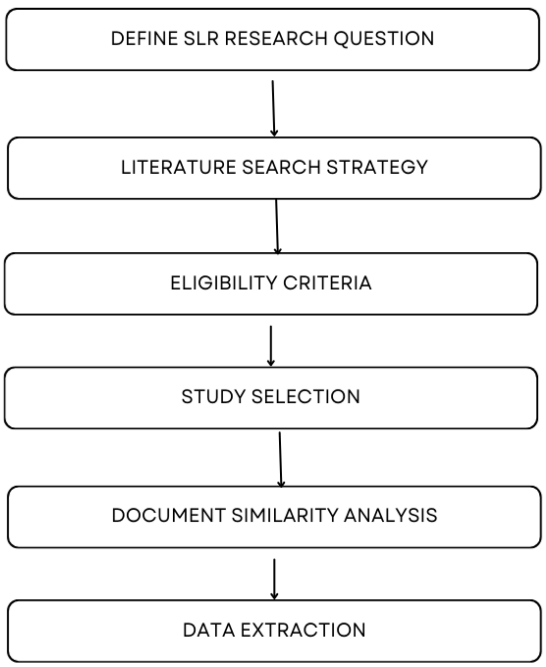

Figure 4: Summary of SLR Protocol

3.4 Search Strategy

This study implemented a meticulous search strategy, involving a comprehensive survey of the existing literature, journals, and systems about the challenges of ownership within the IT industry. It included scrutinizing past papers, research journals, and academic papers that revolved around related and similar subjects. The study utilized databases such as IEEE Xplore, Google Scholar, Emerald Insight, Science Direct, and other relevant databases. Additionally, targeted searches were conducted in reputable journals and conference proceedings within the IT, IoT, and software engineering domains in an unbiased manner, based on specific research questions.

In addition to exploring academic databases such as IEEE Xplore, Google Scholar, Emerald Insight, and ScienceDirect, a detailed approach was adopted to gather information from reputable industry websites and other online platforms. The search encompassed both the academic literature and practical insights available on websites relevant to the IT industry. This dual-pronged strategy aimed to capture a holistic understanding of ownership challenges in the IT domain, considering academic perspectives, as well as insights and experiences shared on industry platforms. The inclusion of non-academic sources contributed to a well-rounded exploration of multifaceted issues surrounding ownership in the IT sector.

In November 2023, peer-reviewed articles about the problems of ownership of information technology were sought through the identified research databases and reputable websites. Utilizing the prescribed Boolean search terms outlined in Table 1, the literature search were systematically refined to retrieve relevant literature that aimed to extract valuable insights and perspectives on ownership challenges in the IT industry.

Table 1: Search Query

	Search Query
SQ1	ownership AND (IT OR information technology OR problem OR challenge OR issue)
SQ2	ownership AND (IT OR software OR IOT OR management OR rights)
SQ3	ownership AND (IT OR information technology OR entity management OR asset management OR distributed)
SQ4	ownership AND (IT OR software development OR transfer policies OR governance)
SQ5	ownership AND (IT services OR IT industry)
SQ6	ownership AND (IT projects OR software development OR management OR assignment)
SQ7	ownership AND (virtual assets OR IT content OR repositories OR IT ecosystem OR tech firms)

SQ8	ownership AND (IT organizations OR IT industry OR possession OR challenge OR dispute OR conflict)
SQ9	ownership AND (IT OR software development OR intellectual property OR rights)
SQ10	ownership AND (IT OR tech firms OR uncertainty OR conflict)
SQ11	ownership AND (IT OR data access OR software organization OR problem OR challenge OR stakeholders)
SQ12	ownership AND (IT industry OR software development OR responsibility OR possession)
SQ13	ownership AND (IT OR tech firms OR documentation OR models OR tracking OR responsibility)
SQ14	ownership AND (IT OR software development OR governance OR intellectual property)
SQ15	ownership AND (IT OR software OR asset)
SQ16	ownership AND (IT OR information technology OR software OR hardware OR cloud)
SQ17	ownership AND (IT industry OR item OR IT entity)
SQ18	ownership AND (IT industry OR asset OR IT asset)
SQ19	ownership AND (IT OR software development OR model OR tracking method)
SQ20	ownership AND (IT OR tech firms OR resource OR intellectual property)

3.4.1 Search Strategy Validation

These search queries were executed on Google Scholar and IEEE Xplore to validate and test the efficacy of these search queries. The main purpose of these using these queries was to identify scholarly articles that describe and address the various aspects of ownership within the IT domain, including the problems, challenges, and management. This process involved running each of the search query across the selected databases and analyzing the results to ensure that they returned relevant articles that are aligned within research objectives and using ML tools such as zotero manager to maintain these search results. The results was documented in an excel file.

This test confirmation process was conducted by evaluating the number and relevance of the articles retrieved by each query. The is to make sure that the search queries were broad enough to capture a wide range of literature while remaining specific enough to avoid and filter out unrelated results.

3.5 Eligibility Criteria

A systematic screening process was conducted to filter the identified literature based on pre-defined selection (inclusion and exclusion) criteria. This also make sure that only the most relevant high-quality studies were included in the review.

The selection criteria for this study were based on the PRISMA statement (Moher et al., 2009) and included studies that addressed problems of ownership in the realm of Information Technology (IT). Specifically, inclusion criteria were defined for studies that answered one or more research questions, had a timeframe beyond 2010, utilized a Systematic Literature Review (SLR) approach, concentrating on the convergence of IT and ownership, incorporated two or more keywords in their research, were available in the English language, and had a length exceeding two pages. These criteria were rigorously applied to ensure the inclusion of relevant and comprehensive literature in the research synthesis and mapping processes.

Table 2: Inclusion and exclusion criteria

Inclusion Criteria	**Exclusion Criteria**
Studies above 2 pages	Studies below 2 pages
Studies available in English	Studies not available in English
Studies whose timeframe > the year 2010	Studies whose timeframe is < the year 2010
Studies that focus on IT OR ownership	Studies that do not focus on IT OR ownership
Studies that answer one or more research questions	Studies that do not answer one or more research questions

Studies that include two or more research keywords	Studies containing only one research keyword

3.6 Study Selection and Data Selection Process

This systematic review utilized Covidence, an AI tool specifically designed for the screening of titles and abstracts. Covidence integrates a multi-stage review process, including data extraction, into its design (Kellermeyer et al., 2018).). To ensure transparency and objectivity in the analysis, a detailed account of the rigorous selection process was provided.

The study selection process involved identifying and removing any duplicate studies to streamline the review process. The remaining studies underwent preliminary screening based on predefined inclusion and exclusion criteria (Gunawan et al., 2018). This initial screening, based on abstracts, helped narrow the selection to studies that exhibit potential alignment with our research objectives. Final selections were made through a comprehensive examination of the full texts, ensuring that the studies met the research criteria and contributed to the systematic review.

3.7 Quality Assessment

Once the final selection of studies was made, a comprehensive evaluation and analysis of the chosen articles was conducted. This assessment covered multiple dimensions, such as document similarity and keyword similarity. It also involved using TF-IDF (Term Frequency-Inverse Document Frequency) alongside cosine similarity in Python, a method that quantifies the similarity between two non-zero vectors. This approach is frequently used in information retrieval and text mining to compare document contents and uncover similarities. By applying cosine similarity, the review can determine the relevance and connections between different studies and research papers, particularly about the concept of ownership within IT, IoT, and software organizations.

The model consisted of three processes: data extraction and preprocessing, TF-IDF calculation, and computation of similarity and scoring.

3.7.1 Keyword Extraction and Data Preprocessing

In addressing the complex challenges of ownership in the realm of information technology, A significant part of this study concentrated on pinpointing keywords related to ownership issues. This effort employed advanced methods, including term frequency-inverse document frequency (TF-IDF), to discern and prioritize noteworthy terms. By employing this approach, the research ensured a concentrated and nuanced analysis, shedding light on the crucial aspects of ownership in the information technology industry.

Furthermore, this section placed great emphasis on the significance of data preprocessing. The collected data underwent meticulous refinement to guarantee its relevance and accuracy in the subsequent stages of analysis. This step is vital in augmenting the quality of information and extracting meaningful insights into the intricacies of ownership issues within the information technology domain.

3.7.2 Cosine Similarity Using Text Classification

Cosine similarity is a metric used to assess how similar two vectors are, and it is widely used within the inner product measure family. In text classification, it helps determine the degree of similarity between two documents. The similarity score ranges from 0 to 1, where 0 represents no similarity and 1 indicates that the documents are identical (Park et al., 2020).

The formula for cosine similarity between two nonzero vectors is:

$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum\limits_{i=1}^{n} A_i B_i}{\sqrt{\sum\limits_{i=1}^{n} A_i^2} \sqrt{\sum\limits_{i=1}^{n} B_i^2}},$$

A noteworthy innovation in this study entails the amalgamation of TF-IDF and Cosine similarity to suggest articles, considering the user's prior articles. This original technique exhibited exceptional outcomes when compared with similar approaches, as indicated by the F-measure criterion.

3.8 Data Extraction

The selected studies underwent a comprehensive data extraction process, where pertinent information was meticulously gathered and analyzed. This process focused particularly on issues and challenges related to ownership, as identified in the literature, encompassing areas such as data ownership, access rights, intellectual property rights, and the ownership of software and IoT devices.

Table 3: Data Extraction

Information Extracted from Articles	**Description**
Title	The title of the article.
Author	The names of the authors of the study.
Year	The year of publication.
Keywords	The main keywords or terms associated with the article.
Quality Score	The rating or assessment of the article's quality.
Challenges	The key challenges identified in ownership of IT.
Solutions	The specific ownership management practices discussed or implemented in the study.
Asset Type	The specific asset/entity/item/property discussed in the study.

CHAPTER 4

RESULTS

This systematic review was meticulously carried out and documented, adhering to the quality standards specified in the PRISMA 2009 checklist [REF] for systematic reviews. Two reviewers independently and (I added "and") meticulously conducted the selection of studies, evaluation of their content, and extraction of relevant data. We employed the use of the Covidence software, which proved to be an invaluable tool in efficiently screening, selecting, and extracting pertinent data from the studies that were included in our analysis.

4.1 Study Characteristics

During phase I, utilizing broad literature searches across multiple databases and websites, a total of 209 articles were initially identified through academic databases such as IEEE Xplore, Google Scholar, Semantic Scholar, Emerald Insight, and ScienceDirect using the search terms. Additionally, thirty-eight articles were found on reputable websites such as Core BTS, Dataversity and Permission.io. The selected articles were then imported into the reference manager Zotero and the review manager Covidence. (Dijk et al., 2023) where 3 duplicate articles were removed. This study utilized an article scraping approach to gather text from websites and platforms in the research domain. A custom Article Scraper was implemented in Python, leveraging the 'newspaper' library for scraping articles. The scraper navigated to the provided URL, retrieved the HTML content, and extracted the article text while ensuring adherence to ethical considerations and terms of service of respective websites. After acquiring the article text, an automatic summarization technique, specifically the 'sumy' library's LSA (Latent Semantic Analysis) summarizer, based on the extracted text was employed to create a more manageable dataset for subsequent analysis. The summarized content was then associated with each article and stored in our dataset's 'Abstract' column for further processing before undergoing the screening phase.

In Phase II, the titles and abstracts included in each article found were read, leading to their screening to eliminate those that were not on the topic of ownership, selecting only those in which the authors included ownership and asset type in their research, and discriminating between the articles that exclusively studied ownership in Information Technology and those that included it with other areas. Of these, 263 were selected as potentially eligible based on their title and abstract. In certain cases, the term "ownership" appeared in the abstract as secondary to the study or simply as a reference; thus, the pre-established selection criteria, including both inclusion and exclusion factors, were applied to identify all relevant articles for the systematic review.

Articles were included if they addressed ownership in the field of information technology, provided answers to one or two research questions, and were published within a period later than the year 2010. Moreover, only articles written in English were included to ensure consistency in understanding and interpretation. Exclusion criteria were also applied to refine the selection. Articles were excluded if they were less than two pages, not related to ownership in information technology, or if they were published within a timeframe before the year 2010. Additionally, Articles that were not available in full text were excluded from the study. Applying the inclusion and exclusion criteria led to the final selection of 50 articles for comprehensive evaluation and analysis in the systematic review. During Phase III, the articles were reviewed for data extraction, and as all necessary articles were available in full, none were excluded at this stage. The study selection process is illustrated in Figure 5.

Finally, in Phase IV, the identified articles were analyzed using cosine similarity.

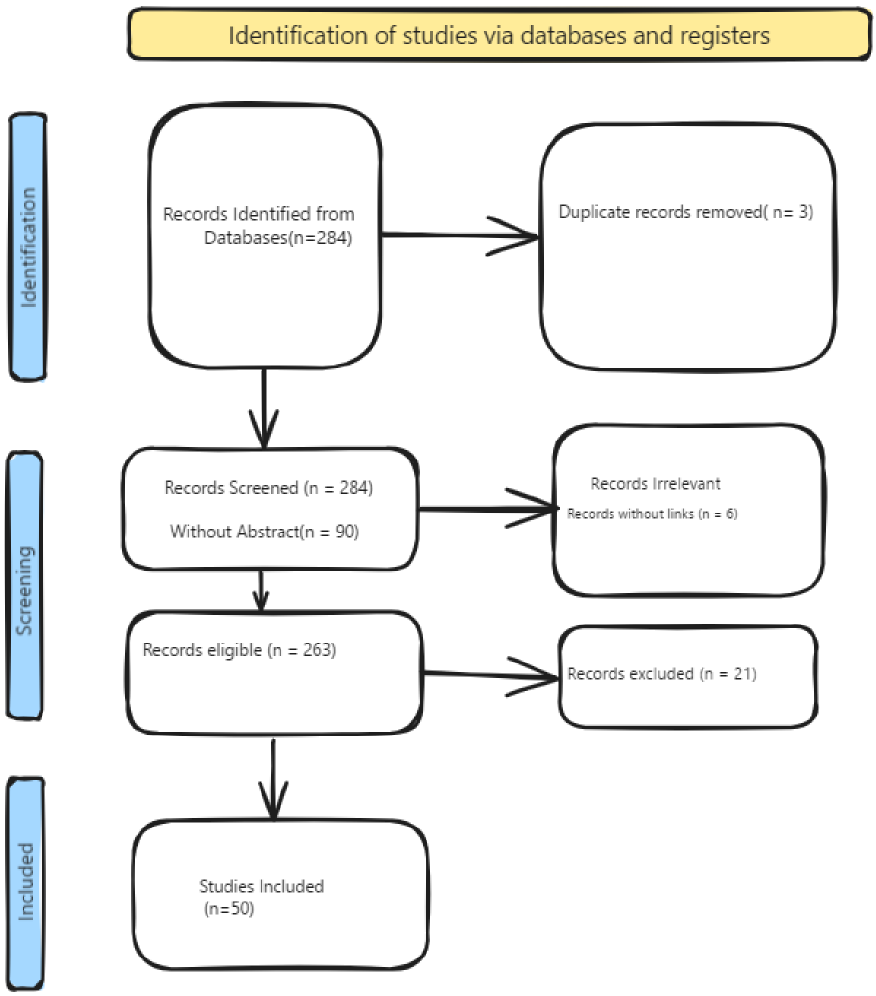

Figure 5: Flow diagram of the study selection process

The subsequent sections detail the primary studies according to their assigned ID codes. Based on the standardized information extracted from these papers, the publications relevant to this systematic literature review are mostly journals and conference papers with 23 (46%) and 12(24%) respectively, web articles with others being lesser. (See Fig. 6). The 50 studies were published in English.

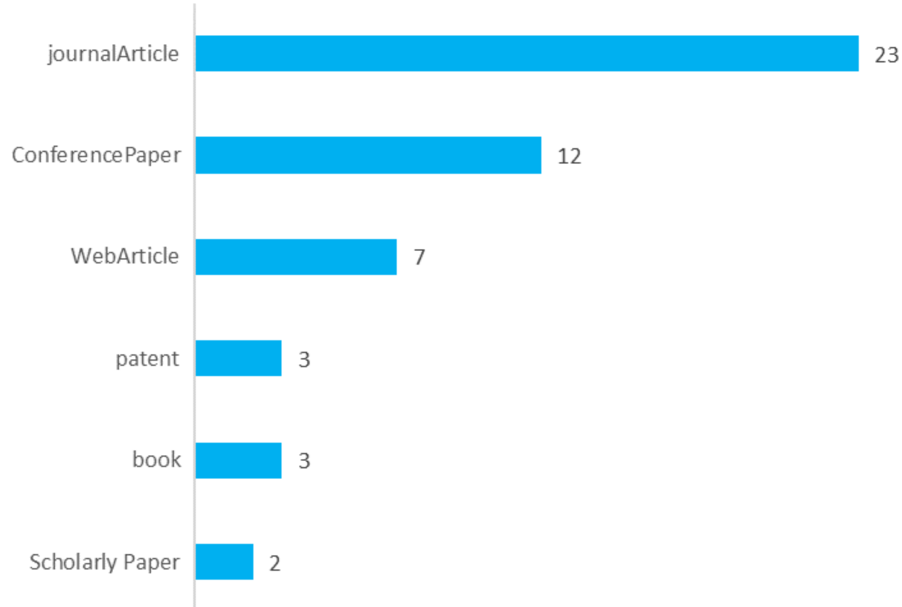

Figure 6: Studies Included Type

Figure 7 displays the distribution of the included studies based on their publication years, highlighting the number of articles published in each year. The count displays the number of studies conducted or published during that specific timeframe, with variations observed among the years, with a distinct prominence of higher counts in 2020, 2018, and 2021 than in other years.

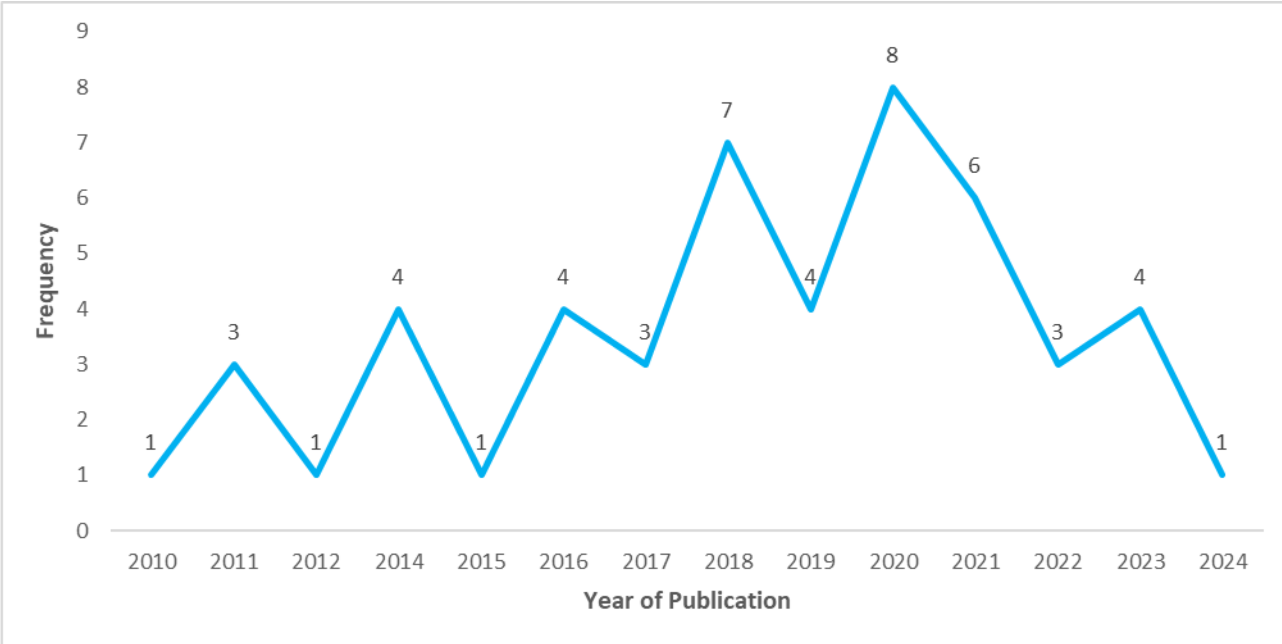

Figure 7: Publication Year

Despite the prevalence of different subindustries across the Information Technology sector, Fig (8) shows that there has been a significant interest in the system software and Application software accounting for 34.00% and 20.00% of the studies reviewed. Business Services (16.00%), Internet Services & Infrastructure (16.00%), Data Processing and Outsourced Services (8.00%) and IT Consulting and Other Services (4.00%), Technology Hardware, Storage & Peripherals (2.00%) were less represented while Communication Equipment and Technology Hardware, Storage & Peripherals were not represented.

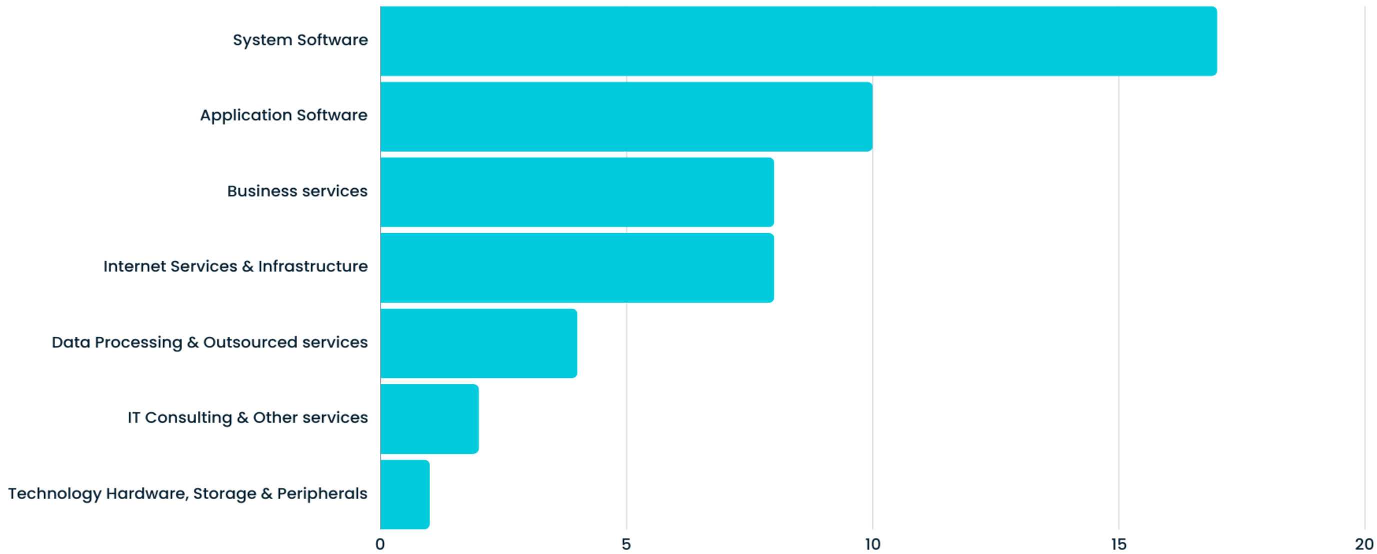

Figure 8: IT Subindustry Studied

Figure 9 shows that the Qualitative method (41) was the most used, followed by quantitative (5) and mixed method (4)

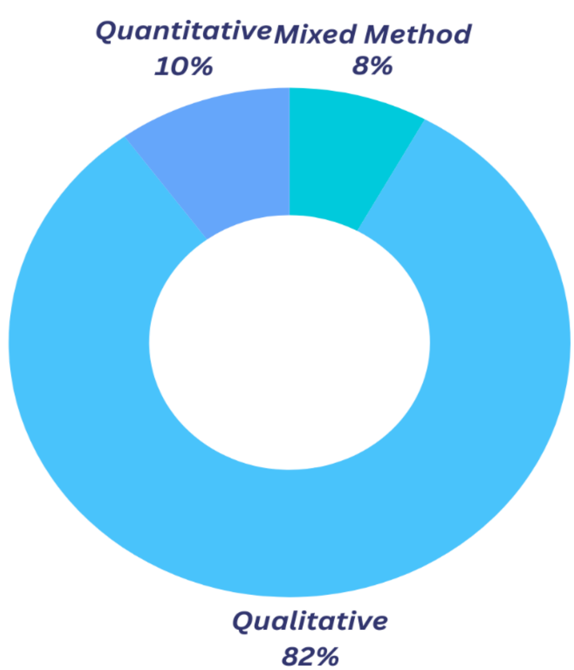

Figure 9: Study design employed by studies selected.

4.2 Document Similarity and Keyword Analysis

This section discussed the implementation of the text relevance approach to identify related documents, the implementation of TF-IDF and cosine similarity analysis was performed using Python (Appendix 5). Before analysis, we performed text pre-processing to maintain the integrity and consistency of data.

The text pre-processing stage involved essential procedures which began with punctuation removal, followed by the application of case folding to convert all letters to lowercase. After applying case folding, tokenization was applied to segment the text into separated tokens. Some of these tokens were removed if the term is listed in the stop word list.

Following text preprocessing, we extracted keywords using TF-IDF vectorization in combination with the TfidfVectorizer from sci-kit-learn to identify important terms within each document. This process allowed us to identify and prioritize important terms that contributed most to the overall content and context of the documents.

Subsequently, we calculated the text relevance using TF-IDF and cosine similarity analysis in Python. The TF-IDF analysis allowed us to quantify the importance of terms within each document and generate TF-IDF vectors representing the documents' content. By applying cosine similarity, we measured the similarity between pairs of documents based on their TF-IDF vectors. Text relevance is calculated by using cosine similarity, where a value that is closer to 1 is considered more relevant and similar, and values closer to 0 suggest a lower degree of similarity.

The results of TF-IDF and cosine similarity revealed varying degrees of document similarity across the selected studies. Notably, several articles exhibited high cosine similarity scores, indicating substantial overlap in their content and subject matter. These findings suggest the presence of common themes and research interests among these studies.

The analysis of TF-IDF and cosine similarity yielded significant knowledge regarding the connections and resemblances among the selected studies. This data adds to a deeper understanding and comprehension of the research domain and can direct the determination of pertinent topics and associations within literature. These discoveries augment the comprehensiveness and strength of our systematic review, enabling a more comprehensive and subtle interpretation of the collected information.

4.3 Data Extraction: Qualitative Synthesis

The research reports include narrative summaries of individual reviews and have organized the review data based on different types of ownership and comparisons among the investigated studies. The extracted table lists the fifty studies pertinent to this systematic literature review, providing the following information: title, author, year of publication, citations, keywords, challenges, solutions, and quality scores obtained. The themes are presented in the figure below

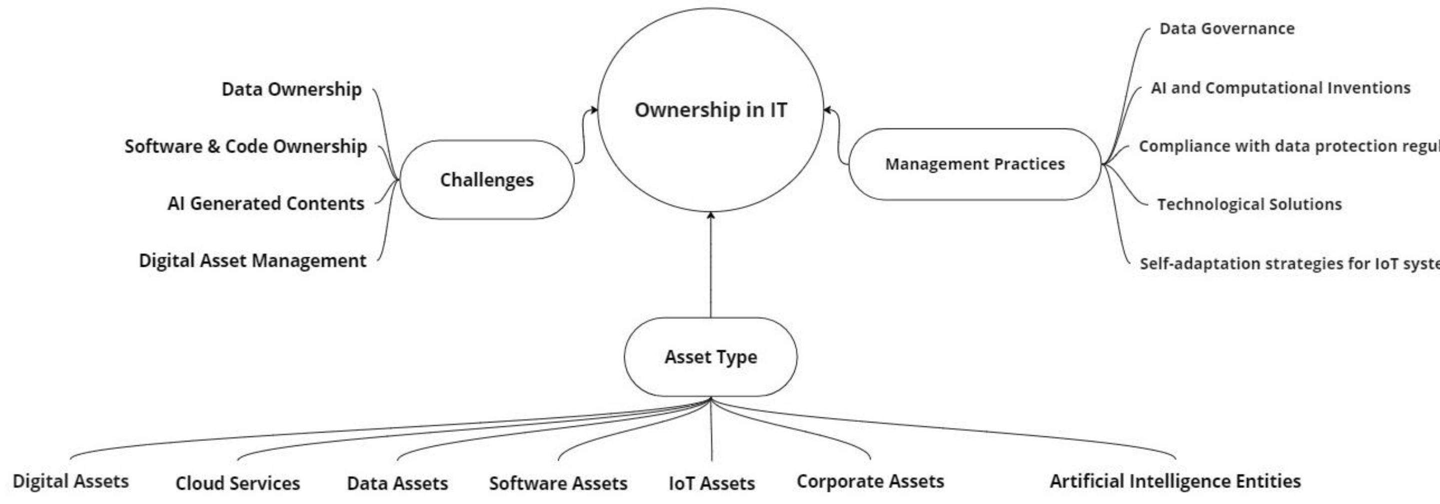

Figure 10: Themes from the qualitative synthesis

4.4 Summary of Findings

The analysis revealed the intricate nature of ownership challenges in the IT sector, emphasizing the necessity for a holistic approach that combines data governance, intellectual property management, and adherence to legal frameworks. The research developed a comprehensive approach to ownership management in the IT sector, incorporating hybrid and decentralized models, distributed ledger technologies, and frameworks such as OCAM. By systematically reviewing and analyzing 50 relevant studies from academic databases, grey literature, and reputable websites, the research provides critical insights into the complexities of managing ownership. The study addresses key issues such as data ownership, intellectual property rights, and the impact of legal and regulatory frameworks, emphasizing the need for an integrated approach that includes robust data governance and intellectual property management.

The findings highlight the crucial role of technological solutions, such as blockchain, in ensuring transparency and implementing secure data protocols. The study emphasizes the need for clear contractual agreements and cross-sector collaboration to standardize and unify ownership practices. It also introduces a streamlined framework for ownership management that integrates robust legal structures, technological innovations, and clearly defined ownership policies.

By tackling these ownership issues, the research seeks to improve the protection and management of IT assets. It lays the groundwork for future investigations by examining various asset types within the IT sector and understanding how ownership dynamics differ across these types. This holistic approach enables organizations to more effectively manage and protect their digital resources, thereby enhancing control and security over valuable IT assets. The literature reviewed reveals several common asset types relevant to ownership management in the IT industry

Digital assets, software assets, cloud services, IoT assets, corporate assets, and artificial entities.

We provide a generalized recommendations for Ownership management across asset types, given the unique characteristics of each asset, tailored solutions are necessary:

Digital and Software Assets: Management of these assets relies heavily on intellectual property frameworks and robust version control mechanisms. Legal agreements, copyright laws, and licensing agreements help establish clear ownership rights and ensure compliance.

Corporate and Cloud Assets: Governance processes and regulatory compliance play a crucial role in managing ownership of corporate and cloud-based assets. Effective ownership management involves developing and enforcing policies that address data security, access controls, and operational transparency.

IoT and Artificial Entities: For IoT and AI assets, the literature emphasizes the need for a combination of legal clarity and technical mechanisms for ownership assignment and transfer.

This includes defining ownership of both physical devices and the data they produce, as well as establishing protocols for secure data transfer and usage.

In the context of our Research Question 2: Ideas for Ownership Management in the IT Industry

This research question explores effective solutions and strategies for managing ownership within the IT industry. The documents reviewed emphasize the importance of leveraging both emerging technologies and innovative models to ensure clear, secure, and equitable ownership management. The literatures analyzed suggested several key solutions for managing ownership in the IT sector:

Distributed Ledgers (Blockchain): Various documents suggest that distributed ledger technologies, like blockchain, offer a promising solution for secure and transparent ownership management. Blockchain provides an immutable record of ownership and facilitates secure transfers and tracking of digital assets, reducing the risk of disputes and unauthorized use.

Hybrid Models for AI Ownership: The literature discusses the complexities of ownership related to AI models, algorithms, and outputs. A hybrid ownership model is suggested, where rights are shared among developers, data providers, and end-users, ensuring that contributions from different stakeholders are recognized and managed effectively.

Shared Ownership File Access Controls: Effective management of digital assets, particularly those involving multiple contributors or stakeholders, can be achieved through shared ownership models combined with robust file access controls. This approach helps in defining access rights, editing privileges, and ownership responsibilities.

Decentralized Systems for Data Ownership: Decentralized systems, which distribute data storage and management across multiple nodes, are recommended for managing data ownership. These systems prevent single points of failure, enhance data security, and provide more equitable control and access rights to data.

OCAM Model (Ownership and Contribution Assignment Model): The OCAM model is highlighted as an effective framework for distinguishing between ownership and contribution in collaborative environments. It provides clarity on who owns what and ensures fair attribution of contributions, minimizing conflicts and fostering collaboration.

We proposed a generalized solution for ownership management by adopting a combination of hybrid and decentralized models:

Hybrid and Decentralized Models: These models are essential for managing ownership in environments where multiple stakeholders are involved. Hybrid models accommodate shared ownership, allowing for flexible arrangements where rights can be split or co-owned. Decentralized models, such as those enabled by blockchain, offer secure and transparent mechanisms for ownership transfer and verification.

Distributed Ledger Technologies: Blockchain and other decentralized technologies are recommended for secure ownership transfer, providing a transparent, immutable ledger that records every transaction. This technology reduces the risk of ownership disputes, enhances trust among parties, and provides a reliable mechanism for tracking ownership changes over time.

Frameworks like OCAM: The OCAM model ensures a clear differentiation between owners and contributors in collaborative environments, fostering better communication, reducing conflicts, and promoting fair recognition of all parties involved. By distinguishing between contribution and formal ownership, organizations can maintain clarity over intellectual property and contributions, which is critical in collaborative and innovative settings.

In the context of our Research Question 3: Challenges Related to Ownership in the IT Industry

This research question seeks to identify the main challenges that organizations face regarding ownership within the IT sector and to propose generalized solutions to these challenges.

Firstly, the big question why do we need ownership needs to be address for us to understand the motivation behind the needs for this research. Ownership itself is a foundational concept in the IT industry because it defines who has the right to use, modify, share, or sell digital assets. Clear ownership helps ensure accountability, security, and compliance with legal and regulatory requirements. Without well-defined ownership, organizations face challenges such as unauthorized use, data breaches, intellectual property theft, and costly legal disputes. Moreover, clear ownership promotes efficient management and utilization of digital resources, fostering innovation and collaboration.

From the documents we reviewed, we identify the common ownership challenges in the IT industry.

Data Privacy and Security: Maintaining data privacy and security presents a major challenge, particularly when ownership is shared or transferred across multiple parties. The lack of clarity regarding who owns the data and who is responsible for its security often leads to vulnerabilities and breaches.

Lack of Clear Ownership: Many organizations struggle with unclear ownership rights, especially in collaborative environments where multiple stakeholders contribute to digital assets. This lack of clarity can result in disputes, conflicts, and inefficiencies in managing digital resources.

Fragmented Ownership: In the IT industry, ownership of digital assets is often fragmented across multiple entities, fragmentation creates uncertainty and potential disputes over rights, responsibilities, and usage, complicating the establishment of a definitive source of truth concerning ownership.

Code Quality Issues: Ownership problems also extend to software code. Poorly defined ownership can result in ambiguous responsibility for maintaining code quality, leading to technical debt, bugs, and security vulnerabilities.

Legal Disputes Over AI-Generated Content: With the rise of AI, new challenges emerge regarding ownership of AI-generated content. The documents highlight the lack of clear legal frameworks to govern ownership rights of content produced by AI systems, leading to potential disputes and conflicts.

Without a clear ownership structure, these might often leads to problems of conflicts and ambiguity. We proposed a generalized solutions/recommendations to address ownership challenges. The documents reviewed propose several strategies to overcome these ownership-related challenges in the IT industry:

Implement Robust Legal Model Frameworks and Governance Models: To address the challenges of unclear or fragmented ownership, it is crucial to establish comprehensive legal frameworks and governance models that clearly define ownership roles, rights, and responsibilities. These frameworks should be adaptable to emerging technologies like AI and IoT, ensuring that all stakeholders understand their rights and obligations.

Adopt Technical Solutions: Utilizing technical solutions such as distributed ledger technologies (e.g., blockchain) can provide secure, transparent mechanisms for verifying and transferring ownership. Additionally, standardized APIs can facilitate ownership verification across different platforms and systems, reducing ambiguity and ensuring consistency.

Incorporate Psychological Ownership: Encouraging a sense of psychological ownership among stakeholders can enhance responsibility and accountability. When individuals or teams feel a personal stake in the digital assets they manage or create, they are more likely to act responsibly, ensure security, and maintain quality.

4.5 Limitations

The study has limitations: based on the inclusion/exclusion criteria, studies selected was restricted to systematic literature review English studies, potentially excluding studies from other languages and studies that is not systematic literature review.

Future investigators should focus on conducting empirical research to validate and refine the ownership management practices identified in this review. Case studies, surveys, and experiments can provide valuable in depths into real-world implementation and effectiveness of these practices. Targeted research in each sub industry can yield more nuanced and actionable insights for practitioners.

Additionally, future investigators should examine the broader societal impact of ownership management practices. This can inform policy discussions and help align ownership frameworks with societal values.

CHAPTER 5

Conclusion

The systematic review revealed widespread ownership challenges in IT, ranging from data control and digital asset management to software piracy and AI-generated content. Key findings include the necessity of clear ownership policies, robust digital asset management systems, and cross-sector collaboration to address ownership complexities. This study provides a foundational understanding of ownership dynamics within IT and highlights the critical role of legal and technological frameworks in enhancing ownership management. The research highlights the necessity of tailored strategies for managing different asset types. For digital and software assets, intellectual property frameworks and version control mechanisms are essential. Corporate and cloud-based assets benefit from governance processes and regulatory compliance to manage data security and operational transparency. For IoT and AI assets, a combination of legal clarity and technical solutions, such as distributed ledgers, is crucial for assigning and transferring ownership. Blockchain, for example, offers an immutable record of ownership and secure data protocols that minimize disputes. Shared ownership models and access controls also play a critical role in defining rights and responsibilities among multiple stakeholders. The study further identifies major challenges in ownership, including data privacy and security concerns, unclear and fragmented ownership rights, and legal disputes over AI-generated content. These issues often arise due to poorly defined ownership structures, leading to conflicts, inefficiencies, and security vulnerabilities. To address these challenges, the research recommends implementing comprehensive legal and governance frameworks that define ownership roles, adopting technical solutions like blockchain and standardized APIs for ownership verification, and fostering psychological ownership to promote accountability and responsibility among stakeholders.

CHAPTER 6

Recommendation

To address the challenges identified in this study, a comprehensive framework for ownership management is proposed. This framework combines robust legal structures, technological solutions such as blockchain for enhanced transparency, and well-defined ownership policies. It is designed to provide IT organizations with effective tools for navigating ownership complexities and safeguarding their digital assets.

Future research should concentrate on refining and implementing these strategies to create a balanced approach to managing ownership issues in the IT sector. This includes integrating legal, technical, and psychological solutions: legal frameworks offer clarity and structure, technical tools like distributed ledgers ensure transparency and security, and fostering psychological ownership enhances accountability and responsibility. Adopting this multifaceted approach aims to mitigate risks associated with unclear or fragmented ownership and foster a culture of collaboration, trust, and innovation.

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Appendix 1: Problems of Ownership in IT and Asset Type

Category	Issues	Asset Type
Data Ownership	Data Control Legal ambiguities Security concerns Data Privacy Ownership Rights Voluminous and heterogeneous data	Cloud Services Data Asset IoT Assets
Software & Code Ownership	Software piracy Patent infringement Copyright violations Data Quality Data Reliability Data Security Lack of clear lines of Responsibility.	Software Assets Corporate Assets
AI Generated Content	Ownership rights Originality and Authorship Copyright violations	Artificial Intelligence Entities
Digital Asset Management	Data Acquisition Ownership and authenticity	Digital Assets

Appendix 2: Generalized challenges/solutions based on each asset types

Asset Types	Generalized Challenges	Generalized Solutions
Digital Asset	Insufficient mechanisms to establish ownership and usage rights. Data breaches and illegal surveillance on social media. Psychological ownership and user engagement complexities.	Implementing distributed ledgers for secure attribution and transfer. Utilizing decentralized systems like block chain to return data ownership to users. Encouraging designs that facilitate psychological ownership.

	Increasing power differential between corporations and individuals. Constraints on rights and abilities for customers to service their property.	Developing principles for digital data and information commons. Enacting national and international legislation to protect intellectual property rights.
Software Asset	Lack of responsibility and knowledge about code ownership. Chain of responsibility in large software systems. Relationship between ownership measures and software failures. Code review process challenges. Security vulnerabilities in blockchain programs. Data access, alignment, and quality issues.	Refactoring system architecture principles for stronger ownership Including reviewing activity in code ownership studies. Recommendations for source code change policies and resource utilization. Implementing heuristic and machine-learning approaches for code review. Empirical methods to improve programming language design. Strategic approaches like data governance and team building.
Artificial Entity	Copyright legislation challenges with AI-created content. Ownership and protection issues of AI-generated patentable inventions.	Proposing hybrid ownership models involving AI and legal entities. Reconciling patent systems with the development of computational inventions.
Data Asset	Tangibility, exclusivity, non-rivalry, and non-excludability of data ownership. Ethical, social, and policy challenges with Big Data practices. Securely transferring device ownership. Data privacy issues and misalignment between ownership and contribution.	Systematizing and comparing various data ownership positions. User-centric approaches to data acquisition and control. Implementing secure and efficient data ownership verification. Proposing models to distinguish between team ownership and contribution.
Corporate Asset	Insiders' ownership affecting firm's value. Ownership structure and corporate governance issues.	Implementing governance processes aligned with international principles.

	Pay-per-use services and public acceptance. Concentrated ownership hindering enterprise value. Friction in capitalization table ledger systems.	Deliberative workshops and group discussions for public perceptions. Regression analysis for equity structure and industry protection. Building models for simplified and friction-free transactions.
Cloud Services	Shared usage of data among owners. Data privacy issues in database systems. Data management challenges in e-maintenance. Ownership issues in business project teams.	New PoW schemes for data ownership verification. Privacy budget management for DBMS users. Standardizing data formats for archiving and exchanging. Shared ownership file access control models for cloud services.
Internet of Things (IoT) Asset	Managing data from IoT devices and transitioning to electronic records. Fragmented ownership in IoT architectures. Security and key management for IoT. Data ownership and human data interaction.	Extending standards and implementing flexible metadata models. Threshold utility principles for IoT ownership. Key management protocols for IoT security. Pay-per-use and data market models for IoT data ownership.

Appendix 3: Answering research questions

RQ1

Paper	Challenges
McConaghy et al., 2017	Insuffcient identification of ownership in digital art
Aziz , 2023	AI system copyright legislation.
Greiler et al., 2015	Lack of responsibility and knowledge about code ownership.
Cai et al., 2023	Data breaches and centralized data ownership.

Hummel et al., 2021	Tangibility and non-rivalry of data ownership.
Banterle, 2018	Ownership of AI's patentable inventions.
Bird et al., 2011	Relationship between ownership and software failures.
Jiang et al., 2020	Shared usage of data and challenges in ownership verification.
Lakmal, 2014	Corporate governance and ownership challenges.
Cherry & Pidgeon, 2018	Ownership in Pay-per-use services and public perception.
Kirk & Swain, 2018	Psychological ownership and legal complexities of digital technologies.
Prainsack, 2019	Power differential between corporations and individuals over data ownership.
Ajay Raina & Palaniswami, 2021	Fragmented ownership in IoT architecture.
Romdhani, 2017	Security challenges in IoT ownership.
Chowdhury & Dhawan, 2016	Ownership in smart city data models.
Weidong Mao et al., 2014	Data storage and access challenges.
Çetin et al., 2021	Challenges in the code review process related to ownership.
Alfonso et al., 2021	Challenges in software deployment, resource allocation, and ownership of IoT systems.
Ulrike M. Graetsch et al., 2023	Data quality and access challenges related to ownership.
Zabardast et al., 2022	Misalignment between ownership and contribution.
Wu & Guo, 2018	Concentrated ownership and its negative impact on enterprise value.
Addagada, 2018b	Data ownership challenges in enterprise management.
Nero, 2021	Lack of ownership in software development projects.
Bloor, 2020	Exploitation of personal data by big tech companies.
Boyd & Solarino, 2016	Ownership of corporations and its effect on firms.
Ownership and On-Call, 2023	Lack of accountability due to diffusion of ownership across teams.
Core BTS, 2022	Ownership issues in custom applications.

Research Question 2

Papers	Ideas
McConaghy et al., 2017	Distributed ledger for secure attribution and transfer.
Aziz, 2023	Hybrid ownership model for AI systems.
Greiler et al., 2015	Refactoring binaries to strengthen code ownership.
Thongtanunam et al., 2016	Chain of responsibility for code reviews.
Cai et al., 2023	Decentralized social data system for data ownership.
Banterle, 2018	Interpretative solutions for AI patent system.
Hummel et al., 2021	Four dimensions of data ownership.
Bird et al., 2011	Recommendations for ownership policies in software projects.
Jiang et al., 2020	PoW scheme for ownership verification in cloud services.
Koana et al., 2024	Nine software ownership artifacts (most prevalent).
Lakmal, 2014	Governance processes to align corporate ownership.
Cherry & Pidgeon, 2018	World Cafe-style discussions for Pay-per-use ownership
Prainsack, 2019	Designing principles for digital data commons.
Sodring et al., 2020	Standard API for IoT data ownership.
Bormida, 2021	User-centric approach for Big Data ownership.
Ajay Raina & Palaniswami, 2021	Threshold utility principle for IoT ownership.
Mashhadi et al., 2014	Pay-Per-Use, Data Market, and Open Data ownership models for IoT.
Mangalam College of Engineering & Radhakrishnan, 2019	Shared ownership file access control in the cloud.
Zabardast et al., 2022	OCAM model for ownership vs. contribution in software development.
Chowdhury & Dhawan, 2016	Five data ownership models in smart city data
Boyd & Solarino, 2016	Synthesizing ownership types in corporations.

Berti Suman et al., 2020	Emerging models of data governance.
Addagada, 2018a	Tailored enterprise data management models.
Nero, 2021	Defining team ownership in software projects
Crichton, 2020	Ownership model in Rust programming.
Tulsi et al., 2021	Ownership model for asset management.
Osborne et al., 2018	Transfer of IoT ownership using digital certificates.
Ownership and On-Call, 2023	Establishing explicit service ownership.
Core BTS, 2022	Managing Total Cost of Ownership mindset in custom software development.

Research Question 3

Papers	Asset Type
McConaghy et al., 2017	Digital Asset
Aziz, 2023	Artificial Entity
Greiler et al., 2015	Software Asset
Thongtanunam et al., 2016	Software Asset
Cai et al., 2023	Digital Asset
Hummel et al., 2021	Data Asset
Banterle, 2018	Artificial Entity
Bird et al., 2011	Software Asset
Jiang et al., 2020	Cloud Services
Lakmal, 2014	Corporate Asset
Cherry & Pidgeon, 2018	Digital Asset
Prainsack, 2019	Digital Asset
Ajay Raina & Palaniswami, 2021	IoT Asset

Romdhani, 2017	IoT Asset
Sodring et al., 2020	IoT Asset
Bormida, 2021	Data Asset
Mangalam College of Engineering & Radhakrishnan, 2019	Cloud Services
Mashhadi et al., 2014	IoT Asset
Zabardast et al., 2022	Software Asset
Chowdhury & Dhawan, 2016	IoT Asset
Boyd & Solarino, 2016	Corporate Asset
Addagada, 2018b	Data Asset
Crichton, 2020	Software Asset
Tulsi et al., 2021	Corporate Asset
Nero, 2021	Software Asset
Osborne et al., 2018	Data Asset

Appendix 4: Link to github repo.

https://github.com/OladeleAlo/Oladele_Uni_Thesis