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Research Article

Unlocking Internet of Things (IoT) for Enhanced Knowledge Management and Organizational Performance: A Case Study of Diverse Industry Players in the Philippines

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ABSTRACT

Web 3.0 resulted in the increased decentralization of information, especially upon the emergence of the Internet of Things (IoT). IoT has revolutionized data transfer and has since reshaped knowledge management in organizations. This research focuses on how the IoT enables real-time data sharing and its impact on enhancing knowledge management and business processes in various local businesses. The study examines how five Philippine enterprises utilize the IoT through a qualitative embedded cross-case analysis. Several methods, like interviews, focus groups, and questionnaires, helped gather insights into how the IoT influences knowledge management processes. The research follows a case study approach, and the findings reveal that IoT boosts the generation, storage, sharing, and utilization of knowledge, aiding organizations in enhancing operational efficiency and product and service quality, thus improving business processes. Further, the research offers insights into the IoT possibilities. It provides practical recommendations for seamless integration through the companies' capabilities that enhance their knowledge management and operational results, gaining insights for strategic implementation.

Keywords: *Internet of Things, Knowledge Management, Organizational Performance, Internal Process Perspective, Value Creation*

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Introduction

The effectiveness of contemporary organizations is contingent upon their adeptness in leveraging knowledge and their capacity to adapt to dynamic situations. Ongoing technological improvements facilitate the possibility of enabling this behavior as they enhance the decision-making processes, operational efficiency, flexibility, and employee involvement of these firms (Hermawan & Suharnomo, 2020; Zirar, Ali & Islam, 2023). Significantly, the advent of technology has brought about a substantial alteration in the operational processes of organizations, resulting in the reduction of many hindrances such as impediments to communication, inefficiencies in job execution, complications in management, and the necessity for widespread outsourcing (Hermawan & Suharnomo, 2020; Zirar, Ali & Islam, 2023).

Web 3.0 has been implemented during a period characterized by increased availability of structured data on the internet. This advancement has reduced the necessity for human searches, rendering web pages as just indexes (Anwar, 2022; Kapoor et al., 2017; Spivack, 2007). In addition, the "Semantic Web" concept has provided computer systems with the ability to grasp and efficiently utilize recorded information (Bhattacharya, n.d.; Narayanasamy et al., 2022). Machine learning and artificial intelligence are used in Web 3.0 to facilitate the customization of content distribution (Kerner, 2022; Jha, 2022).

The Internet of Things (IoT) has become a worldwide communication network in which networked objects effectively exchange and respond to data provided via the Internet (Donaldson, 2022; Trend Micro, 2023). The Internet of Things (IoT) offers advantages in multiple industries by providing organizations with immediate access to operational data, resulting in cost savings, enhanced safety protocols, and improved product and service standards (Gillis, 2022; Kumar, 2019; Rijmenam, n.d.).

The present research examines the correlation between the integration of the Internet of Things (IoT) and knowledge management, exploring how this integration contributes to improving organizational performance within the framework of evolving models and technological advancements (Hermawan & Suharnomo, 2020). The primary focus of this study revolves around the present application of the Internet of Things (IoT) in the context of the Philippines and its subsequent influence on knowledge management and organizational performance. This study provides significant contributions by examining the utilization of IoT in knowledge management practices among specific companies in the Philippines. It sheds light on how these organizations leverage IoT to improve internal performance. The research offers a comprehensive understanding of the IoT capabilities of these companies, facilitating performance assessment and strategic decision-making. Moreover, it is a valuable reference for developing IoT adoption strategies and navigating evolving market dynamics. Additionally, this study contributes to the existing body of knowledge on IoT, knowledge management, and organizational performance, making it a valuable educational resource that can be incorporated into academic curricula.

This paper provides an overview of the frameworks that have contributed to the conceptual and operational aspects of the study. It also discusses the research methods employed, presents the findings, and thoroughly discusses the results. Finally, the paper concludes by offering recommendations and suggesting directions for future research.

Methods

The development of the conceptual framework for this study involved the consideration of four noteworthy frameworks:

IoT Components

In his comprehensive study, Mohamed (2020) undertook an extensive examination wherein he analyzed and juxtaposed different Internet of Things (IoT) frameworks to distill their core principles into three main paradigms: Internet-Oriented IoTs, Thing-Oriented IoTs, and Semantic-Oriented IoTs. As depicted in Figure 1, the paradigms were further classified into middleware, sensors, and knowledge, forming the Internet of Things (IoT).

Within the confines of this particular study, the framework in question played a crucial role by serving as a standard against which the variable of the Internet of Things was evaluated.

This research aids in understanding the hardware, network, and software configurations utilized in the Internet of Things (IoT) ecosystem, hence providing insights into how these technological aspects impact the daily operations and activities across various departments within enterprises.

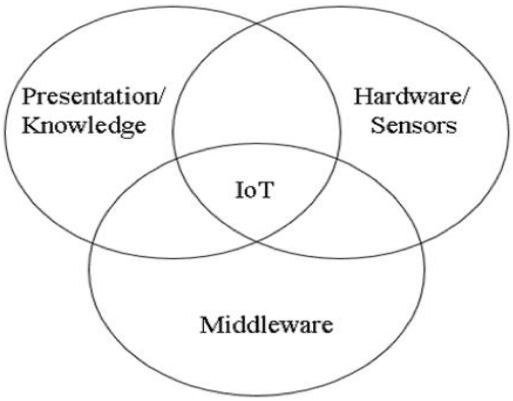

Figure 1. IoT Components

Data Information Knowledge Wisdom (DIKW) Model

Jennifer Rowley is credited with conceptualizing the Wisdom Hierarchy of Knowledge Management. The author's paradigm is based on an extensive examination of previous research conducted by researchers throughout history, specifically focusing on models of data, information, knowledge, and wisdom. Rowley (2007) conducted a comprehensive review of several academic sources, and the synthesis process has led to the creation of a comprehensive framework, as depicted in Figure 2.

Within the field of knowledge management, this model provides a comprehensive understanding of the complex process by which signs undergo a transformation and ultimately become knowledge. The procedure begins by transforming signals into data through transaction processing equipment. Data plays a vital role in the management of information systems, facilitating the generation of important and pertinent information. Decision support systems (DSS) are integral to manipulating and organizing information within companies, enabling the development of expert systems and the generation of knowledge. According to Rowley (2007) and Netexplo and UNESCO (2019), as one moves from data to learning, there is a noticeable increase in interpretation, practicality, human engagement, relevance, and structural complexity. Simultaneously, there is a proportional decline in the significance of machine inputs.

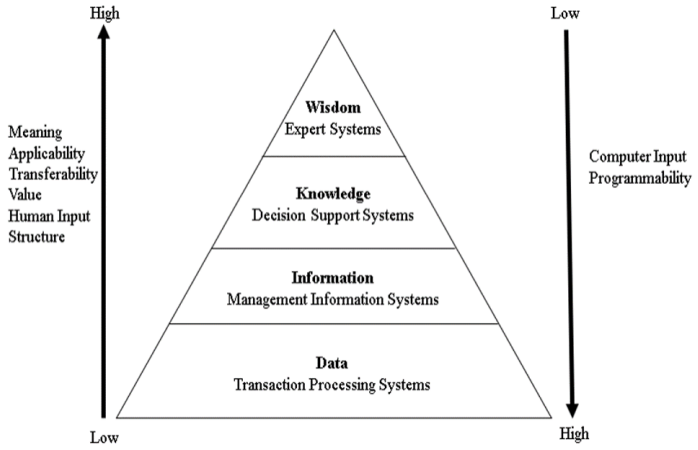

Figure 2. Hierarchy of Knowledge Management (Rowley, 2007)

In the context of our study, this specific model played a pivotal role by illustrating the interdependence between the Internet of Things (IoTs) and knowledge management. The Internet of Things (IoT) is the primary means through which data is gathered from sensors or devices and subsequently communicated to middleware or networks. Within this framework, the data is subjected to processing and transformation to produce practical insights that organizations may utilize to gain knowledge and strategic foresight, augmenting their competitive edge.

Knowledge Management Process

Gonzalez and Martins (2017) made a significant contribution by emphasizing the diverse characteristics of Knowledge Management (KM) and acknowledging its substantial influence on both organizational practices and scholarly discussions. The researchers embarked on a commendable effort to conceptualize the complex knowledge management (KM) process, as seen in Figure 3.

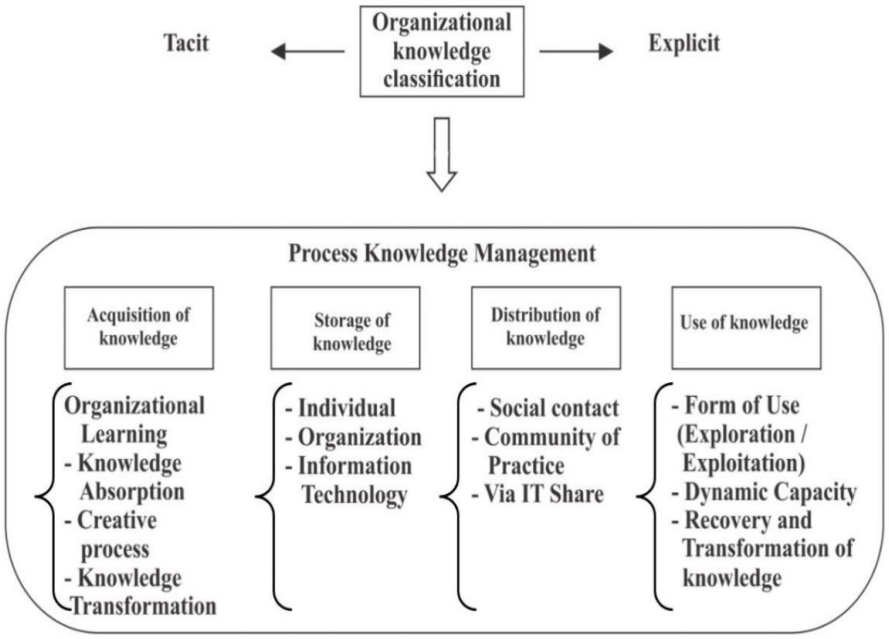

Figure 3. Knowledge Management Process (Gonzales & Martins, 2017)

This is used as the fundamental basis for defining the knowledge management processes in this particular research. More precisely, it functioned as the fundamental framework, facilitating the progression into the relevant phases of the operational structure such as Knowledge Acquisition, Storage, Sharing, and Utilization, harmoniously harmonizing with the suggested framework.

Balanced Scorecard

Organizational performance assessment has been the subject of much discussion and analysis within professional and academic communities. According to Madsen and Stenheim (2015), the Balanced Scorecard (BSC) is widely recognized as a key performance-measuring approach in management and accounting. The importance of this subject has been emphasized by several experts throughout history, such as Modell (2012), Kaplan (2012), and Hoque (2014).

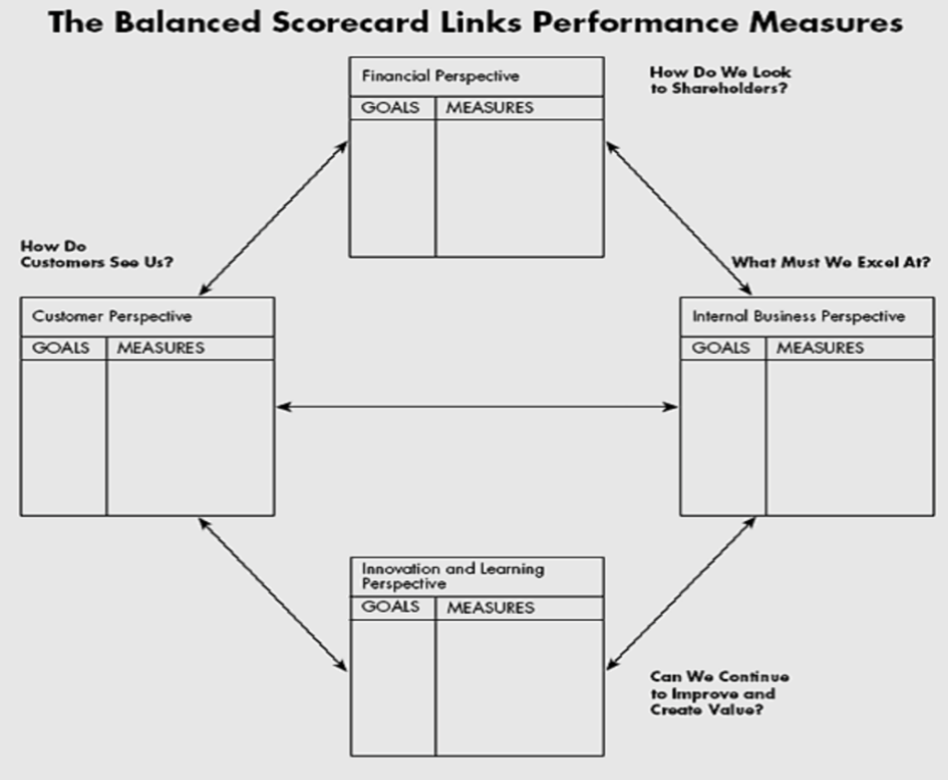

Figure 3. The Balanced Scorecard Links Performance Measure (Kaplan & Norton, 1992)

Given these factors, the researchers intentionally chose to utilize the Balanced Scorecard (BSC) as the principal instrument for assessing non-financial performance within the business. The decision to include this excerpt was motivated by the inherent capability of the Balanced Scorecard (BSC) to offer significant insights into the impact of Knowledge Management (KM) on organizational performance, as illustrated in Figure 4. The alignment between Knowledge Management (KM) and the Balanced Scorecard (BSC) is crucial for assessing their interconnection.

Furthermore, the study's foundation is built upon the conceptual underpinnings of three pivotal perspectives: (a) Customer Perspective, (b) Process Perspective, and (c) Learning and Growth Perspective. These perspectives have been seamlessly integrated into the operational framework to elucidate the dynamic relationship between IoT and KM and how this interaction culminates in enhanced organizational performance.

Drawing from the research findings of Lin (2015) and similar to the outcomes of the study by Thuong and Singh (2023), it becomes apparent that a positive correlation exists between various knowledge factors and BSC outcomes. Lin (2015) expounds upon how the non-financial dimensions of the BSC, including Learning and Growth, Internal Process, and Customer Satisfaction, exert a dual impact on financial perspective, directly and indirectly, through a cause-and-effect relationship.

Building upon these insights, the researchers seamlessly bridged the gap by connecting the four fundamental Knowledge Management processes and the distinct perspectives delineated within the BSC framework. This linkage is a foundational element of the conceptual and operational frameworks, illuminating the dynamic interplay between Knowledge Management and the Balanced Scorecard and its profound implications for organizational performance. Figure 4 below integrates Knowledge Management Orientation Dimensions with the Balanced Scorecard Outcomes.

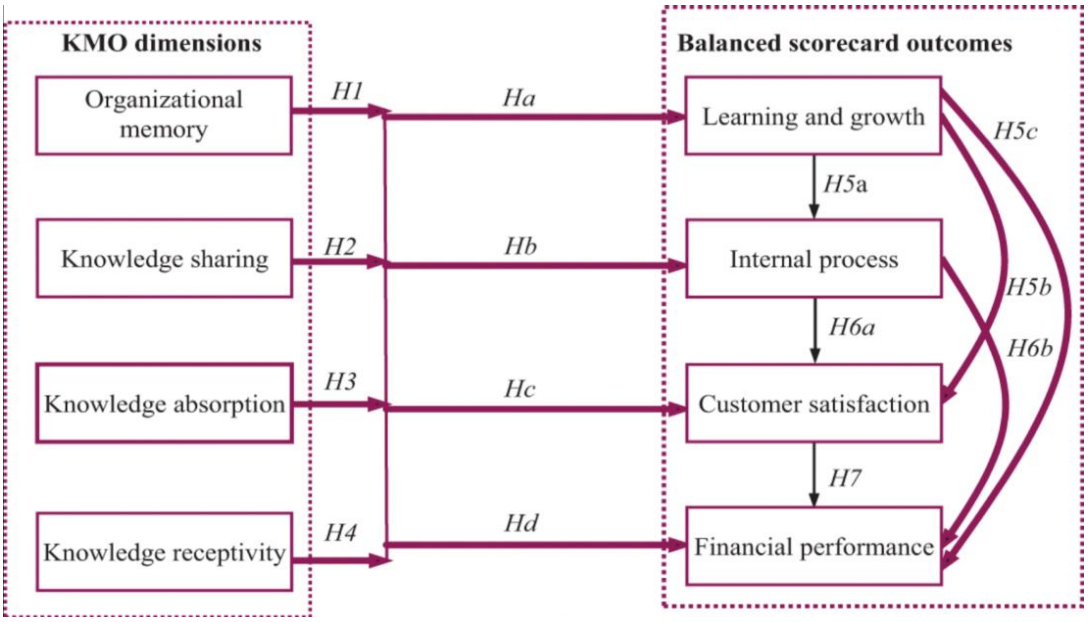

Figure 4. Linking Knowledge Management Orientations to Balanced Scorecard Outcomes (Lin, 2015)

The conceptual and operational framework depicted in Figure 5 is utilized to examine the effects of Internet of Things (IoT) applications on knowledge management and, consequently, on the organizational performance of a corporation. This framework has two fundamental groups of variables: an independent variable and a dependent variable. The independent variable in this study is the Internet of Things, whereas the dependent variable is the knowledge management process.

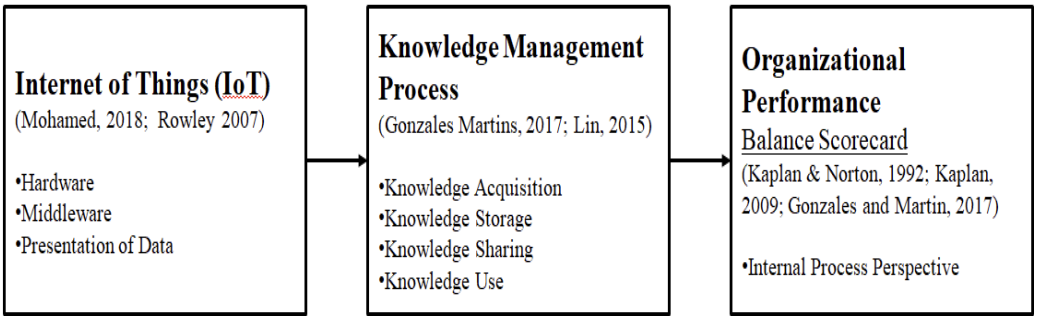

Figure 5. Conceptual and Operational Framework

The framework demonstrates the utilization of Internet of Things (IoT) applications, which involve gathering data from users of Smart devices. This assertion is supported by the findings of Uden and He (2017) and Lokshina and Lanting (2019). Acquiring knowledge through data gathering is crucial in influencing decision-making inside organizations. According to Kurilovas et al. (2014) and Anwar (2022), Web 3.0 tools can obtain necessary information for the functioning of devices or applications and enhance their predictions by considering user preferences. This technology ultimately leads to a more customized user experience. The framework focuses on three vital components for a technology to be categorized as IoT: Hardware, Middleware, and Presentation of Data, as illustrated by Mohamed (2020). Hence, the DIKW model proposed by Rowley (2007) is a conceptual framework that establishes a connection between the Internet of Things (IoT) and knowledge management. This model sheds light on the process

of converting data into knowledge, which is aided by information systems.

According to Al-Mamary et al. (2015) and Bunteng (2022), evaluating organizational performance often involves assessing the extent to which employees complete their responsibilities and the level of achievement of corporate objectives. This process is commonly used as a measure of effectiveness. Therefore, organizational performance is used as the dependent variable to assess the impact of IoT applications on a firm's knowledge management operations. This metric provides significant insights into the tangible organizational advantages resulting from adopting IoT technologies. The methods used to assess Organizational Performance are based on the Balanced Scorecard theory, originally formulated by Kaplan and Norton in 1992 and expanded upon by Kaplan in 2009. This study aims to assess the effects of Knowledge Management processes, with a particular emphasis on the Internal Process Perspective of the company.

The methodology proposed by Gonzales and Martin (2017) is utilized in this study to assess the many dimensions of Knowledge Management processes, including Knowledge Acquisition, Storage, Knowledge Sharing, and Knowledge Use. The study conducted by Lin (2015) establishes a connection between the Balanced Scorecard Theory and the processes involved in Knowledge Management. This research sheds light on the interrelationships among various metrics within the Knowledge Management process. The researchers have effectively established connections between the independent variable, "Internet of Things," and the dependent variable, "knowledge management," within the Internal Process Perspective, highlighting their impact on organizational performance. This framework has been carefully constructed to facilitate this analysis. This framework aims to provide local firms with significant insights into the possible use of IoT technology to enhance organizational performance, specifically in the context of improving Knowledge Management processes.

The researchers have identified the following propositions based on the integrated models and the conceptual and operational frameworks.

P1: IoT helps in improving knowledge management processes.

P2: Knowledge Management Process improves organizational performance through internal processes.

The primary focus of this study is on five companies currently engaged in business operations within the Philippines. The data-gathering process encompassed online communication and a combination of methods, including interviews and interactions, to employ a qualitative case study methodology. This strategy aimed to ensure analytical generality and construct validity. This study investigates the influence of the Internet of Things (IoT) on knowledge management and organizational performance by establishing a connection between theoretical concepts and empirical findings. Additionally, the researchers employed purposive sampling to select cases that met specific criteria of significance. Informants were selected based on predetermined criteria – that they should have been part of the company for at least five years and that they are familiar with the entire operation of the organization, especially those involving IoT as well as the knowledge management practices of the company.

Results

The case descriptions for five anonymized cases labeled as Cases A, B, C, D, and E are presented. These case descriptions aim to examine the impact of the Internet of Things (IoT) on Organizational Performance, specifically Knowledge Management. Additionally, a Cross-Case Analysis will be presented to analyze the findings further.

Data triangulation was performed using interviews, focus-group discussions, and surveys.

Case Descriptions: Cases A, B, C, D, and E

Case A

Case A is a company that operates at the convergence of software and social media, with a particular focus on media management and software solutions designed for content creators. The company provides specialized tools and services that are designed to meet the

needs of creators, brands, and media organizations operating within the ever-evolving terrain of the contemporary creative media economy. The researchers selected Case A as their subject of study based on their proficient use of social media tools to enhance media management and develop data-driven plans across various platforms for their clientele.

IoT Capabilities. The senior editors of Case A engaged in a discussion regarding the potential utilization of social media tools such as Meta Business Analytics and Snapchat Analytics Dashboard on client platforms. In addition, Airtable was referenced as a complete database utilized for the management of client-related information and assets. Airtable is equipped with an application programming interface (API) that facilitates the extraction of data from YouTube channels belonging to clients. This extracted data is subsequently utilized to generate asset codes specifically intended for video editing. The automation system was contracted out, employing an if/then algorithm. Basecamp is an additional Internet of Things (IoT) tool employed for storing and managing client analytics and portfolios.

During the focus group discussion, participants emphasized the utilization of Basecamp and Airtable as effective tools for database management and workload tracking, specifically among senior video editors and production assistants. In general, the findings of the poll suggest that there is a moderate level of ambivalence towards the capacity of the Internet of Things (IoT) to convey information, as evidenced by a mean score of 3.8 and a standard deviation of 1.09. Nevertheless, the participants generally reached a consensus regarding the ability of Internet of Things (IoT) hardware and software to effectively retain information (M = 4.2, SD = 0.83).

IoT and Knowledge Management

Knowledge Acquisition. In Case A, it was reported that Internet of Things (IoT) solutions, such as Meta Business Suites, can collect various data types, including audience demographics, retention data, and viewer engagement metrics. Simultaneously, API integration is centered around extracting video-related assets and automating asset code development for workload visualization. The findings from the focus group discussion (FGD) revealed that Case A employs the Internet of Things (IoT) technology to visualize and optimize its workload, specifically emphasizing enhancing audience retention. Basecamp is used for project planning and asset management. Furthermore, the findings from the survey reveal a substantial consensus (M = 4.8, low SD = 0.45) about the capacity of the Internet of Things (IoT) to facilitate the acquisition of data and information for knowledge acquisition.

The concept of knowledge storage. The data obtained through Meta Business Suites is converted into digital Portable Document Format (PDF) files and afterward stored in Basecamp, functioning as a portfolio that both internal personnel and clients can access. Additionally, the organization is characterized as being rudimentary, prioritizing practical learning over formal databases. The survey results indicate a high level of agreement about the convenience of saving knowledge (M = 4.6) and the efficacy of utilizing stored knowledge (M = 4.4).

The primary method employed in this case for knowledge dissemination is oral communication. Access to information from IoT technologies is granted on a need-to-know basis. According to the survey findings, there is a prevailing neutral perspective (M = 3.2, low SD = 0.44) about freely disseminating knowledge inside the organizational context.

Internet of Things (IoT) tools provide valuable insights into video editing operations, platform posting tactics, and monetization decisions. In addition, they effectively oversee the distribution of tasks and maintain effective connections with clients by utilizing the Internet of Things (IoT). The survey results indicate a significant level of comprehension in using IoT for knowledge purposes (M = 4.2). Still, participants are yet to feel the ease of implementing IoT for knowledge management (M = 3.2).

Knowledge Management and Organizational Performance: Internal Process Perspective

Knowledge Acquisition. Case A demonstrates increasing familiarity with the utilized platforms, resulting in enhanced operational efficiency. Acquiring knowledge of the Internet of Things (IoT) offers significant advantages to

top-level executives and clients, as it facilitates improved audience engagement and content editing capabilities. The acquisition of knowledge in video editing is contingent upon the specific criteria put forth by the department. This process entails a focus on assets and editorial judgments for video editors, as well as the implementation of organizational strategies for production. The survey results suggest that employees perceive their organization as more effective in internal operations, with a mean score of 4.4. The organization believes that their clientele exhibits high satisfaction, as indicated by a mean score of 4.0. However, they maintain a neutral stance on the potential enhancements in customer services and innovation, as reflected by a mean score of 3.2. The participants exhibit a predominantly neutral stance towards personal productivity while utilizing their knowledge of the Internet of Things (IoT), with an average rating of 3.8.

Knowledge Storage. The appropriate administration of files is crucial for storing knowledge, as it facilitates future reference and the ability to explain procedures to new clients. Retaining data serves to present clients with a comprehensive performance display. The findings from focus group discussions (FGDs) and interviews indicate that individuals have reported an enhanced level of comfort with the availability of stored information. However, it is important to note that the specific, measurable advantages resulting from this improved comfort are still not established.

Knowledge Sharing. The dissemination of knowledge is contingent upon hierarchical structures, wherein spoken communication is the predominant means of information exchange. Basecamp is utilized as a platform for facilitating transparent dissemination of information, while Slack is a tool for facilitating internal communication within an organization. Internally, knowledge sharing is limited, emphasizing the efficient dissemination of need-to-know information.

Knowledge Use. The importance of audience retention and market demography cannot be overstated in the context of Case A. The data provides valuable insights to editors and assistants, enabling them to enhance customer support and expedite decision-making processes within the dynamic social media business. In their FGD, IoT knowledge usage is limited, focusing on workload efficiency, editing tactics, and client communication. The value attributed to experiential knowledge surpasses knowledge derived through the Internet of Things (IoT).

Case B

Case B is a prominent petroleum trading and distribution company in the CALABARZON region. They specialize in wholesale and retail petroleum products, sourcing high-quality fuels from major suppliers such as Chevron, Phoenix, Unioil, Total, and Seaoil, with a substantial monthly demand exceeding millions of liters, averaging 2.3M to 2.6M. Case B has established strong partnerships with over 300 clients across various industries, including logistics, trucking, barge/vessels, automobiles, shuttles, mining, construction, public transit, and independent gasoline stations. Additionally, they offer comprehensive services that encompass the planning, design, and construction of independent regional gas stations, along with the supply of storage tank pumps.

IoT Capabilities. Case B adopted IoT technologies to manage its loyalty rewards program, timekeeping, and database management. They outsourced their loyalty program management to a payment solutions provider but faced challenges with hardware reliability and slow after-sales support. They established an in-house department to manage the system to address these issues. They also use biometric devices for timekeeping and RFID cards to replace magnetic swipe cards. Additional hardware includes a computer for managing the cloud database to enhance cybersecurity.

Despite the initial hardware challenges, Case B has seen improvements in internal processes and customer service through IoT implementation. Employees find these devices easy to use for knowledge management. While they encountered issues with the credibility of loyalty points, they have implemented safeguards and punishments for fraudulent transactions. Overall, the investment in IoT technology has positively impacted their business operations.

IoT and Knowledge Management

Knowledge Acquisition. Case B gathers knowledge through its IoT systems, including the loyalty rewards program managed by a payment solutions company. Initially, data is acquired through the registration of loyalty cards, and additional information is continuously collected as customers participate in the rewards program. The company utilizes this data to understand customer preferences, adjust promotions, and enhance customer engagement. Additionally, their biometrics system aids in efficient employee timekeeping, improving workforce management.

Data is continually received when loyalty points are used, reflecting transaction details such as vehicle type and spending patterns. This data is stored in a cloud database provided by the payment solutions provider. It helps Case B assess market competitiveness, customer loyalty, and station performance. IoT technology provides essential data for the company's operations.

Knowledge Storage. IoT technology facilitates knowledge storage through various systems, including POS, loyalty card points, and biometrics systems. Data privacy and confidentiality are ensured, with restricted access based on personnel roles. Data is securely stored in systems like Google Drive Sheets, and Case B has smoothly implemented these technologies.

Knowledge Sharing. Further, knowledge sharing is organized based on personnel roles, with different levels of access to systems like POS, loyalty cards, and biometrics. The company promotes data protection and cybersecurity by limiting access on a need-to-know basis. The survey results indicate a positive environment for knowledge sharing among employees, contributing to a collaborative work atmosphere.

IoT technology's primary benefit lies in marketing, allowing demographic discovery, vehicle type analysis, and transaction monitoring. It helps define each station's market and detect discrepancies in transactions. The POS system aids sales monitoring and tax compliance, enhancing business security and productivity. IoT has greatly benefited Case B in marketing, attendance monitoring, and payroll management.

Knowledge Use. Survey results confirm that users find IoT technology easy to use for knowledge management, resulting in improved internal processes, customer service, and product/service innovation. Case B leverages this knowledge to make informed decisions and enhance its operations and customer experience.

Knowledge Management and Organizational Performance: Internal Process Perspective

Knowledge Acquisition. In Case B, knowledge acquisition is facilitated by IoT technology, primarily through the loyalty card system. This system automatically collects customer data and computes loyalty points, aiding the organization in understanding its customer base and identifying areas for improvement. IoT reduces human errors in data collection, making the process more efficient and accurate.

IoT has significantly streamlined business transactions, enhanced efficiency and reduced errors. The technology works for the business, making processes more efficient and saving resources. With IoT, Case B can acquire data efficiently and accurately, benefiting its operations and knowledge acquisition.

Data collected through the loyalty card system helps Case B make strategic marketing decisions, including target market identification and promotion strategies. While The payment solutions company improved manual operations, the company developed custom software to suit its needs better. This new software addresses issues and collects data for customer-specific marketing, improving customer satisfaction.

Knowledge Storage. This process involves utilizing cloud storage for the loyalty card system, ensuring data privacy and accessibility. Biometrics and timekeeping data are stored in Google Sheets, making retrieval efficient. IoT technology provides convenient knowledge storage, allowing the company to easily access and manage large amounts of data.

Knowledge Sharing. This method occurs across departments, with data from the loyalty card system shared with stations, management, IT, and marketing departments. IoT technology simplifies knowledge sharing, making it easier to teach new employees and transfer

knowledge securely within the organization. Survey results highlight the importance of IoT for collaboration and knowledge dissemination.

Knowledge Use. IoT positively impacts organizational performance. The loyalty card system helps the company understand its customers and make data-driven decisions, leading to better outcomes. Supervisors and managers use data for performance analysis, optimizing operations, improving services, and increasing revenue. IoT technology enhances organizational processes, product innovation, and customer service, making it a valuable investment for Case B's business operations.

Case C

Case C is a renowned Filipino Buffet restaurant chain with multiple branches in Metro Manila, Philippines, known for its commitment to offering high-quality, affordable Filipino cuisine. They take pride in showcasing traditional dishes like adobo, *sisig*, and *okoy*, creating an atmosphere that mirrors the warmth and togetherness of a Filipino household. Case C goes the extra mile by providing convenient options for its customers, including delivering ready-made and frozen dishes through Grab Food. The researchers selected Case C as a case study due to their effective utilization of POS systems and GrabFood Merchant, which enabled them to access interconnected information efficiently for their daily operations and swift decision-making.

IoT Capabilities. Case C employs two IoT technologies: GrabMerchant and a POS System. Each branch utilizes both GrabMerchant and POS systems for specific purposes. GrabMerchant handles online orders and deliveries, while the POS system manages sales in physical or actual restaurant locations. These IoT technologies are equipped with software that collects and records essential company data, and middleware that connects these systems to the hardware, facilitating information sharing among key staff members. The hardware setup includes designated phones for GrabMerchant at each branch and dedicated modules for the POS system within the restaurant.

The FGD revealed that restaurant managers play a pivotal role in overseeing the implementation and usage of these IoT technologies, including training employees. GrabMerchant primarily tracks takeout sales, while the POS system monitors sales within the restaurant itself.

Survey responses from five employees generally indicate agreement with the effectiveness of these IoT technologies in storing and visualizing the necessary knowledge from their hardware and software components. These activities align with the insights provided during the interview and FGD about the capabilities of these IoT systems.

IoT and Knowledge Management

Knowledge Acquisition. In the interview, the owner of Case C described their knowledge acquisition process as highly convenient. They utilize two IoT technologies, GrabMerchant, and a POS system, to gather valuable insights. GrabMerchant records order volume, inventory status, and real-time delivery locations, with daily email updates to the owner. The POS system focuses on daily customer sales data.

During the focus group discussion (FGD), it was highlighted that these IoT technologies, especially crucial for a buffet restaurant like Case C, automatically summarize inventory levels, aiding in efficient restocking. Thus, employee survey responses indicated a positive experience in acquiring specific knowledge through IoT technology, emphasizing its convenience for daily operations.

Knowledge Storage. Each of the two IoT technologies used by Case C maintains its database for knowledge storage. GrabMerchant stores sales and inventory data, allowing the owner to access historical information for continuous improvement. The POS system offers real-time updates, eliminating the need for daily reports.

The FGD echoed the owner's insights on knowledge storage capabilities. Managers also leverage these systems to enhance sales based on everyday sales information. Hence, survey results showed unanimous agreement among employees regarding the ease of storing knowledge in IoT technologies, ensuring vital information is preserved.

Knowledge Sharing. IoT technologies facilitate knowledge sharing within the restaurant's daily operations. GrabMerchant connects customers to the cashier and kitchen, generating daily reports and total sales updates for the owner. The POS system provides real-time sales and order updates for in-house customers and allows managers and owners access to the database.

The FGD recognized that knowledge sharing through IoT technology is restricted to specific users, with unnecessary details omitted for some staff members, like servers and dishwashers. Verbal sharing occurs when needed. Therefore, the survey respondents concurred that knowledge sharing through IoT technologies is achievable, primarily among users of this information, such as cashiers and cooks.

Knowledge Use. Knowledge of IoT technologies serves both operational and managerial purposes. At the operational level, real-time order tracking from GrabMerchant aids kitchen preparation. Sales and inventory data are crucial for managerial decision-making, enabling inventory restocking and product performance evaluation.

The FGD highlighted GrabMerchant's role in creating a new revenue stream and enhancing order preparation and delivery. Survey feedback indicated that employees can easily use and understand the knowledge acquired through IoT technologies, emphasizing their user-friendliness and effectiveness in processing, and summarizing information.

Knowledge Management and Organizational Performance: Internal Process Perspective

Knowledge Acquisition. During the interview, the owner of Case C highlighted the advantages of IoT technology in streamlining operations. They emphasized how this technology provides real-time information that is easily accessible to key staff members, ensuring smooth and efficient operations. A comparison was made between the current IoT-driven operations and the pre-pandemic era when everything relied on manual recording, which was prone to errors. GrabMerchant and the POS system have automated processes, enhancing productivity and effectively allowing the company to manage orders, inventories, and preparations. The owner also expressed plans to expand into different platforms and upgrade the POS system to encompass various business processes beyond sales management, such as payroll and supplier purchasing. The IoT technologies have reduced the need for micromanagement as they provide all necessary data, ensuring employees can effectively use this knowledge if they have access to the IoT technology.

The FGD depicted the benefits of knowledge management on organizational performance centered on customer interaction, particularly through GrabMerchant. This technology is an intermediary between customer requests and kitchen preparation, streamlining communication and enhancing customer service, ultimately simplifying sales processes.

The survey revealed positive sentiments among employees regarding how knowledge management benefits organizational performance. Most strongly agreed that the organization's internal processes had become more productive. In terms of customer service, they felt that their service had improved, leading to greater customer satisfaction due to the knowledge gained through IoT. Additionally, they agreed that Case C had become more innovative regarding products and services, particularly with the introduction of GrabMerchant during the pandemic. Furthermore, most employees strongly agreed that they felt more productive in their work thanks to the knowledge from IoT technologies, demonstrating how these knowledge management processes had improved organizational performance.

Knowledge Storage. IoT technologies securely and promptly store explicit knowledge. Both the manager and owner noted the benefits of these technologies to organizational performance, citing their real-time updates that facilitate quicker decision-making. The database's historical feature also enables key organization members to access data easily, contributing to continuous improvement in organizational knowledge.

Knowledge Sharing. While knowledge sharing through IoT technologies is limited to key members of the organization—the owner, cashier, and manager—it efficiently facilitates information sharing among them. The manager

and owner found the benefits of sharing knowledge through these technologies convenient, with one-click access to specific data and information. This streamlined communication is especially helpful for the kitchen in preparing orders from GrabMerchant, where orders are directly visible to them.

Knowledge Use. Knowledge utilization benefits organizational performance by promoting faster, real-time communication among stakeholders (customers, employees, and management), increasing daily operational productivity. The owner mentioned that these technologies had significantly boosted sales by providing readily available data and information previously processed manually. Decision-making processes, including product offerings, were informed by IoT-generated sales data. The manager noted that the IoT technologies simplified processes apart from increasing sales, especially for Grab takeout and kitchen preparations. IoT-driven knowledge management greatly improved the restaurant's organizational performance, enhancing customer service and internal productivity by effectively managing essential knowledge.

Case D

Case D, situated in Pasay City, Philippines is a contemporary bed-and-breakfast establishment influenced by the timeless Filipino-Spanish architectural style. It is committed to guest satisfaction and provides complimentary Wi-Fi and parking; Hence, it is consistently earning high ratings on platforms like booking.com and TripAdvisor. The researchers found Case D an interesting case study due to the ongoing integration of AirBnB and Alexa into their operations, which fosters an interconnected environment that significantly enhances their overall operational efficiency.

IoT Capabilities. Case D, a hotel, relies on a range of IoT technologies to support its daily operations, primarily focusing on booking apps (Booking.com, Expedia, Agoda), Channel Manager, Google Home Smart Devices, and Google Workspace.

The owner and manager consider booking applications a crucial IoT technology for attracting customers to the hotel. These third-party apps allow the hotel to list its availability and prices, with the apps handling promotions and knowledge management in exchange for a booking commission. Hardware systems like personal computers and mobile phones are used to access these apps via their websites. Additionally, these booking apps have software capabilities for knowledge acquisition, storage, sharing, and utilization, drawing from years of recorded operations data.

The Channel Manager is a middleware system that connects and monitors all bookings made through various booking apps. Its primary role is to prevent issues like double bookings. The owner conveniently accesses the Channel Manager through their computer, streamlining the monitoring process and avoiding the need to check each app individually.

In the hotel's 13 rooms, Google Home Smart Devices are utilized for entertainment, including TVs and speakers. These devices are connected via Alexa, which acts as middleware, allowing a single command to control all smart devices. Alexa's software, managed by Amazon's cloud-based AI, ensures connectivity between the program, the internet, and the smart devices.

The hotel relies on Google Workspace for knowledge recording, primarily using Google Sheets. This platform facilitates the storage of knowledge acquired through other IoT technologies. Users can access Google Workspace on their personal computers and mobile phones. Furthermore, Google Workspace is middleware for various Google apps, including Google Sheets and Google Drive. It is managed by Google's software, ensuring accessibility for subscribed users.

Accordingly, these IoT technologies play a vital role in the hotel's operations, from attracting customers through booking apps to managing bookings, controlling smart devices, and efficiently recording and accessing knowledge through Google Workspace.

IoT and Knowledge Management

Knowledge Acquisition. The IoT system gathers various data, including daily bookings, check-in/out dates, customer information, and special requests. Third-party messaging apps like WhatsApp and Telegram facilitate self-

check-ins. The IoT technologies process this data and earn a commission for each booking made through them.

Knowledge Storage. The booking apps maintain databases storing historical knowledge, such as client records and past bookings, which are accessible with a simple click. This historical information is considered the hotel's explicit knowledge, essential for staying competitive as a boutique hotel.

Knowledge Sharing. Google Suite apps, particularly Google Sheets, are used for knowledge sharing. Booking details, vacancy dates, and other relevant data are entered into Google Sheets and shared with clients, travel agencies, and other organizational members via email. This real-time sharing is secured in Google Cloud's database.

Knowledge Use. The knowledge acquired through IoT technologies is crucial for managing bookings and optimizing operations. Real-time tracking of guest arrivals and departures aids in in-room preparation. Additionally, the IoT system helps the owner remain competitive by comparing prices and vacancies with competitors and adjusting strategies accordingly. Identifying peak seasons allows for pricing adjustments and promotional offers during lean periods.

In the daily operations, a channel manager system connects and monitors bookings across various apps, preventing double bookings. The hotel has integrated smart devices into a single Google Home system, including speakers and TVs, with Alexa acting as middleware. This setup streamlines device management through voice commands.

Also, the survey results show that employees find it easy to understand and use IoT technology for knowledge management, reflecting positive perceptions of its usability and effectiveness. Thus, the IoT technologies have significantly improved Case D's operations by facilitating knowledge acquisition, storage, sharing, and utilization, enhancing customer service and operational efficiency.

Knowledge Management and Organizational Performance: Internal Process Perspective

Knowledge Acquisition. They describe IoT as a user-friendly and cost-effective approach that simplifies operations with a few clicks on applications. Compared to manual methods, IoT reduces labor stress and minimizes human errors. The hotel utilizes IoT applications, including booking platforms (Booking.com, Expedia, Agoda), a Channel Manager, Google Home Smart Devices, and Google Workspace, enhancing their booking processes, pricing strategies, market understanding, and customer satisfaction.

Knowledge Storage. The IoT technologies efficiently store data, including bookings and reviews, allowing the organization to access historical information dating back several years. This data helps in decision-making, particularly by providing insights into customer experiences and areas for improvement.

Knowledge Sharing. IoT technologies facilitate communication with customers, employees, and management, improving overall customer experience. The hotel has expanded its reach to more tourists, engaged with a broader audience, and made its products and services more accessible. Additionally, IoT technologies enhance staff efficiency.

Knowledge Use. By implementing IoT technologies, the hotel has enhanced its overall organizational performance. It has effectively reached more tourists, engaged with a wider audience, and improved accessibility to its offerings. These technologies have also improved staff efficiency. Overall, IoT technologies have significantly benefited the hotel's organizational performance, leading to better customer service and increased productivity in internal processes.

Case E

Case E, located in Parañaque City, Philippines, comprises E-Agency, E-Creatives, and E-Insights. E-Agency excels in creative communication and brand development, offering integrated marketing campaigns. E-Creatives specializes in media services, encompassing ATL (print, radio, and TV), BTL (OOH and Events Activation), Digital Media (Social Media and Rich Media), and influencer marketing, along with comprehensive media planning and buying. It also has E-Insights, which is a boutique market research firm focusing on quantitative and qualitative consumer research studies.

IoT Capabilities. During the interview, the CEO discussed the extensive use of IoT technologies within their company, highlighting their reliance on third-party software solutions rather than in-house developments. They utilize various data acquisition tools, particularly research, involving diverse tools and subscriptions like AC Nielsen for data gathering. During the pandemic, they heavily relied on Google Workspace for their internal processes.

In the FGD participated by departments, E-Agency, E-Creatives, and E-Insights shared information and perspectives on their IoT utilization. Accordingly, E-Agency and E-Creatives employ similar IoT technologies and software, including Meta Business Suites for Facebook and Instagram dashboards, TikTok Ads Manager/Dashboard, and social listening tools such as Hootsuite, Sprout Social, and Meltwater. These tools collect data from the personal devices of the audience or social media users, such as smartphones, laptops, and tablets. The collected data includes demographics and audience responses to social media posts. Each social media platform has specific algorithms that compile this data into insights displayed on functional dashboards. E-Agency also utilizes QR codes to redirect clients' consumers to e-commerce pages, microsites, or websites, enabling real-time interaction and reducing the time between viewing the material and acting on it.

Across the entire company, both in the FGD and interview, Google Workspace emerged as a key tool for internal processes. During the pandemic, it served as a central hub for compiling information used in creative assets and research. The company also utilizes Google Drive for storing assets and creating specific campaign folders for clients. Furthermore, Google Docs is employed for meetings and attendance management.

Results from their survey indicate that most members of the organization believe IoT technologies are effective in visualizing and storing information, which can be transformed into knowledge. The mean response for the questions related to IoT's ability to visualize data and store knowledge is approximately 4.2 (M = 4.2), with a standard deviation of 0.45 (SD = 0.45), suggesting a general agreement among members regarding the positive impact of IoT technologies on data visualization and knowledge storage.

IoT and Knowledge Management

Knowledge Acquisition. The CEO emphasizes the critical nature of acquiring relevant data in their dynamic industry. Given the ever-changing market landscape, he highlights the need to stay aware and adapt to current trends and strategies. IoT technologies are seen as a valuable complement to enhance employees' expertise. Significant capital investments are made in these technologies to obtain the necessary information.

In the FGD, managers stress the importance of using IoT technologies to determine the direction of their promotional efforts. Acquiring knowledge through IoT helps them visualize data and understand target market locations and preferences, aiding in decision-making and seizing opportunities. Also, according to survey results, members generally agree they can find the data they need when using IoT technology for knowledge acquisition (M = 4.6 and SD = 0.55).

Knowledge Storage. The CEO describes their knowledge storage practices as primarily relying on archiving through Google Drive and other cloud-based solutions. Storing case studies and past experiences, they prioritize trend spotting and real-time data analysis. Checking data availability at least weekly, if not daily, is crucial.

The FGD highlights the significance of this knowledge storage method. It allows tracking market changes, adapting strategies, and centralizing data access across teams, improving productivity. At the same time, the survey results indicate that employees are generally neutral to agreeable regarding the convenience of using IoT technology for knowledge storage (M = 3.4) and have more diverse opinions about the ease of using the stored knowledge (M = 4.0, SD = 0.71).

Knowledge Sharing. The CEO outlines knowledge sharing at both corporate and operational levels. Executives share information to achieve strategic goals and the company values enrichment programs for employee skill enhancement. Transparency is a core principle,

with all relevant IoT-derived data shared with employees and stakeholders to keep everyone informed.

Managers in the FGD highlight how real-time sharing through IoT technology enhances productivity. However, they emphasize the importance of data security, especially concerning sensitive client information. Further, the survey reveals that employees lean toward neutrality and soft agreement when freely sharing knowledge within the company using IoT technology, with M = 3.4 and SD = 0.55.

Knowledge Use. The CEO explains that standard operating procedures guide employees in using the database. Stakeholder meetings involve sharing creative plans and interlocking ideas. Accountability is crucial, with employees responsible for using available information appropriately.

Managers in the FGD discuss how IoT-driven knowledge usage streamlines brainstorming, facilitates performance monitoring, and enhances efficiency in their work. Also, the survey results indicate that employees generally agree they can use IoT-derived knowledge (M = 4.2). Still, there is more diversity in responses regarding understanding this knowledge (M = 4.2, SD =0.84).

Accordingly, the company recognizes the value of IoT technologies in knowledge acquisition, storage, sharing, and use. However, there may be some variations in employee perceptions of their effectiveness and ease of use.

Knowledge Management and Organizational Performance: Internal Process Perspective

Knowledge Acquisition. The CEO underscores the importance of constantly updating knowledge in their industry, which heavily relies on market and audience dynamics. The company promotes opportunities for knowledge gathering through technology, seminars, and training. Transparency and knowledge sharing are emphasized, eliminating the need for excessive explanations, and ensuring preparedness. In the FGD, various departments discuss how IoT technology aids data visualization, particularly for research and media planning. Access to real-time market information and cross-generational knowledge sharing are highlighted.

Knowledge Storage. The CEO describes their knowledge storage as an archiving system without a formal structure, relying on Google Drive. They check and update stored data daily, prioritizing trend spotting and real-time analysis. The FGD participants stress that the central knowledge storage makes the company efficient and reliable. Access to all relevant information in a single location enhances productivity and decision-making. A policy of not reusing ideas within six months promotes fresh thinking.

Knowledge Sharing. IoT technology streamlines workflows, making knowledge sharing easier. TRE Ventures promotes a culture of transparency, ensuring learning is accessible to both corporate and operational levels. Accountability is emphasized, reducing the need for micro-management. In the FGD, departments emphasize the speed, transparency, and accountability achieved through knowledge sharing facilitated by IoT technology. Real-time data access and knowledge sharing across generations are key points.

Knowledge Use. Case E primarily relies on outsourced software and data for knowledge use due to the fast-paced nature of their industry. The CEO mentions reservations about investing in automation due to the constant need for updates. In the FGD, departments use IoT-derived knowledge for data analysis, visualization, and market understanding, enabling them to respond effectively to clients' needs. The convenience and efficiency of using this knowledge are highlighted.

Therefore, Case E recognizes the value of IoT technology in enhancing knowledge management processes across various aspects of their business, with employees experiencing increased productivity and convenience. However, there may be room for improvement in customer service, satisfaction, and innovation.

Cross-Case Analysis:

Individual Interviews Among Cases A, B, C, D, and E

IoT Capabilities. The hardware requirements for IoT technologies in different companies vary based on size and industry. While personal computers and mobile devices are common for accessing IoT technologies across all

companies, industry-specific needs dictate additional hardware. For instance, Case C utilizes specialized hardware like POS systems and mobile phones in the restaurant industry. In contrast, Case D in the hospitality sector employs smart devices such as TVs, speakers, and Alexa to enhance guest experience. Larger companies like Case E standardize personal computers for employees and provide company tablets for research purposes. These variations in hardware requirements reflect industry and size considerations, influencing hardware adoption and usage.

Middleware serves a crucial role in facilitating communication among IoT system components. All five companies employ middleware, albeit with differences in software and technologies. While Cases A and B develop in-house software, Cases C, D, and E predominantly rely on outsourced software. Industry-specific needs and comfort with software shifts influence middleware choices. Case A emphasizes social media and custom software development, while Case E prefers outsourced software for its diverse marketing strategies. These middleware patterns highlight the influence of industry, company size, and specific requirements on middleware selection.

Each of the five companies employs distinct methods in data presentation. Case A uses Airtable and Basecamp to view data ingested from YouTube via an API. Case B utilizes a dashboard program interfacing with the Payment solutions company website and its in-house software. Case C collects data through IoT and POS systems, summarizing and sending it daily to the owner. Case D relies on booking apps to display information about availability, bookings, and client details. Case Eleverages Google Workspace and social media analytics tools, each equipped with its dashboard for data presentation.

In summary, hardware requirements, middleware usage, and data presentation methods in IoT technologies vary among companies due to industry, size, and specific needs. Research in this field should consider these differences better to understand the drivers of hardware and software adoption. Practitioners can benefit from tailoring their IoT strategies to their industry's unique hardware needs and middleware preferences, ensuring efficient operations and data management.

Knowledge Management. Knowledge management encompasses acquiring, storing, sharing, and using knowledge effectively within organizations. In this case study, five diverse companies employ various IoT technologies to enhance their knowledge management processes. These technologies play distinctive roles in bolstering organizational knowledge management:

Hardware Requirements. The hardware components, including personal computers, mobile devices, and specialized equipment, facilitate efficient data collection and analysis. These tools empower employees to gather vital information crucial for decision-making.

Middleware Platforms. Companies use middleware platforms like API, Meta Business Suites, and social media analytics to store and manage data. These platforms are central hubs for employee communication and collaboration, enhancing knowledge sharing and accessibility.

Data Presentation Mediums. The presentation of data through various mediums like dashboards and booking apps enables employees to access and analyze information efficiently. These user-friendly interfaces facilitate data interpretation and support informed decision-making.

Knowledge Sharing Tools. Tools such as Airtable, Ubivelox, Google Sheets, and Google Workspace facilitate knowledge sharing within organizations. These platforms promote transparency and allow employees to access information vital for improving organizational performance.

Transparency and Data Security. All companies prioritize openness in knowledge sharing. However, certain sensitive information is restricted to upper management and owners to ensure data security and privacy.

Therefore, IoT technologies are pivotal in enhancing knowledge management processes within organizations. They enable the acquisition, storage, sharing, and effective use of knowledge, fostering informed decision-making, improved performance, and a competitive

edge. Leveraging these technologies can contribute effectively and significantly to an organization's success and growth.

Organizational Performance: Internal Process Perspective. The adoption of IoT technologies has significantly enhanced the administrative efficacy across the observed companies. These improvements are evident in various aspects of their operations:

Knowledge Acquisition. IoT technology has enabled Case A to access more convenient and in-depth information, enhancing its ability to maximize the use of acquired data. Case B benefits from faster data gathering and reduced human errors, resulting in more reliable software. Case C has achieved increased efficiency through automatic data acquisition, while Case D reports overall improved organizational performance. Case E effectively utilizes IoT-acquired knowledge to develop ideas and guide their operations. Cases C and D also focus on direct client information to understand their customer base.

Knowledge Storage. While these companies employ different approaches to storing knowledge, they all utilize IoT technologies to securely store and update their databases, finding this method efficient and convenient. Cases A and B invest in software updates to enhance convenience and control over their information.

Knowledge Sharing. Companies employ various techniques for sharing knowledge, including funneling down information (Case A), using cloud databases (Case B), real-time sharing (Cases C and D), and promoting transparency (Case E). Cases A, B, and E share knowledge on a need-to-know basis, while Cases C, D, and E emphasize the convenience of real-time information sharing within their organizations.

IoT technologies have enhanced convenience, reliability, and speed in knowledge acquisition, storage, and sharing across these organizations. These improvements empower the companies to continually improve their operations, decision-making processes, and customer understanding.

Cross-Case Analysis:

Focus-Group-Discussion Within Cases A, B, C, D, and E

IoT Capabilities. In this study, it is observed that most companies primarily utilize hardware for communication and sales purposes. However, specific industries, like those involving smart appliances, may have different hardware requirements. Furthermore, these companies heavily depend on outsourced data management services, which can be either paid or free, to support various aspects of their operations, including sales, timekeeping, and collaboration.

Regarding data presentation, dashboards have emerged as the predominant method all companies use. They leverage various software and programs to create and maintain these dashboards. It's worth noting that the choice of software and the type of data presented can vary depending on the specific role and purpose of IoT technology within each company.

Knowledge Management. In knowledge management facilitated by IoT technologies, the primary objective is to collect and transform data into actionable knowledge to enhance organizational operations. The case analysis reveals that explicit knowledge is more easily stored in IoT databases, whereas implicit knowledge poses challenges in terms of storage. Additionally, knowledge sharing via IoT is predominantly oriented toward internal use and is subject to access permissions set by organizational leaders.

The application of knowledge varies across industries, with a common focus on managing critical business processes such as workload, HR, sales, and inventory. It is important to note that the effectiveness of knowledge management through IoT technologies is influenced by the specific industry and the nature of the technology employed, with certain limitations regarding the areas where IoT has access to knowledge. Thus, the success of knowledge management in IoT-driven contexts is closely tied to industry-specific considerations and the type of technology in use.

Organizational Performance: Internal Process. Across diverse industries, many companies derive similar benefits from knowledge

management to enhance their internal processes. This process typically involves gaining insights into their target demographics, tracking repeat customers, and optimizing internal task assignments. Moreover, companies leverage previously gathered knowledge stored in various ways to refine their operations and make informed decisions. While most organizations rely on their databases for this purpose, there is one outlier that places greater emphasis on personal knowledge.

Regarding knowledge sharing, companies tend to have specific methods in place. This method may involve restricting access based on organizational roles or providing information on a need-to-know basis, emphasizing the convenience and accessibility of sharing knowledge selectively.

Furthermore, using knowledge can drive innovation and improvements in products or services. Interestingly, the study reveals that limitations imposed by organizational leaders on specific users' access to knowledge from IoT technologies do not hinder their performance; instead, they help individuals focus on their respective roles as they don't need to be overwhelmed with unnecessary information.

Overall, effective knowledge management is pivotal in enhancing organizational processes, decision-making, and innovation across various industries.

Cross-Case Analysis:

Survey Results Within Cases A, B, C, D, and E

IoT Capabilities. Most companies participating in the study agreed on the capacity of their IoT technology devices to store knowledge, with a collective mean rating of 4.2 and above. The results suggest that IoT technologies can effectively keep the data and information required to enhance organizational performance.

Regarding the presentation of data, most companies also conveyed agreement that their IoT technologies efficiently visualize knowledge, with M = 4.2 and above. This result indicates that IoT technologies provide companies with concise and efficient outputs. However, it is worth noting that a few team members maintained a neutral stance on this question. Specifically, Case A registered M = 3.8, implying that their IoT technologies might not completely meet their expectations regarding generating outputs for the company.

Knowledge Management. Companies generally agree that they can effectively acquire knowledge from IoT technologies, with M = 4.4 and above. This result suggests they can readily access the data and information they require using IoT technology.

In terms of convenience for storing knowledge through IoT technologies, most companies have found it convenient, though there are exceptions. Some members of Case E expressed neutrality on this topic, with M = 3.8, potentially indicating that they did not perceive significant improvements in their data or information storage compared to their previous methods before implementing the IoT.

However, all companies strongly agree that the knowledge obtained from IoT technologies can be easily utilized, as reflected in their mean scores ranging from 4 to 5. Regarding knowledge sharing, there are discrepancies in team members' opinions from different companies. Atmosfarm and Case E have M = 3.2 and M = 3.4, indicating neutrality regarding the freedom to share knowledge through their IoT technology. This result is attributed to permission restrictions and limited data accessibility set by their companies. In contrast, Cases B, C, and D strongly agree, with mean scores ranging from 4.6 to 5, that they are free to share knowledge with others, as it is integral to their operations and aligned with company policies.

Lastly, regarding knowledge use, Cases A, D, and E expressed neutrality about whether their organizations experienced improvements in the innovation of their products or services, with most companies scoring M = 3.4 or lower. However, Cases B and C agreed that their companies had innovated their products or services when utilizing the knowledge gained, with mean scores of 4.2 and 4.4, respectively. For productivity in their work due to IoT technology knowledge, most agreed that they became more productive, with M = 4.2 and above for Cases B, C, and E. The results suggest that implementing IoT technologies positively impacted their work compared to when they did not use IoT technologies. However, some Case A and D team members were neutral, indicating

that they did not observe a significant change in their productivity following IoT implementation.

Organizational Performance: Internal Process. In terms of internal processes, all companies generally agree that their productivity has significantly improved since implementing knowledge from IoT devices, with mean scores of 4 and above. The results indicate a positive impact on operational efficiency compared to the time before IoT implementation.

Regarding customer relations, most companies, specifically Cases B, C, and D, strongly agree that their approach towards customers has improved, with M = 4.4 and above. However, Case A and E expressed neutrality, with mean scores of 3.2 and 3.8, respectively, suggesting that their team members perceive little change in their customer service approach since implementing IoT technologies.

On the other hand, customer satisfaction showed that most companies agree that customers feel satisfied with the knowledge derived from IoT, as reflected in mean scores of 4 and above, except for TRE Ventures, which expressed neutrality with a mean score of 3.6. The results imply that Case E does not closely monitor customer satisfaction following IoT technology implementation in their products or services.

Also, regarding product and service innovation resulting from implementing knowledge acquired through IoT, most companies expressed neutrality, indicating that they did not observe significant advancements compared to the time before IoT implementation. However, Cases B and C agreed that they had witnessed improvements in the innovation of their products/services, with mean scores of 4.2 and 4.4, respectively.

Lastly, most companies reported increased productivity due to knowledge gained from IoT devices, although some team members did not perceive a notable increase in their productivity following IoT implementation.

Data Triangulation Report

IoT Capabilities. Companies exhibit diverse hardware and software requirements influenced by company size, industry specialization, individual preferences, and investment capacity. Smaller companies typically demand less hardware, while specific industries necessitate personal computers for each employee to utilize their IoT technologies effectively. Additionally, the research reveals that companies may opt for outsourcing software or leveraging free IoT solutions as a cost-effective approach to knowledge management if the selected middleware can effectively present the required data. Moreover, the presentation of data heavily depends on software dashboards, as evidenced by all the companies in the study employing them as their primary medium.

Knowledge Management. The research delves into utilizing IoT technologies for knowledge management within companies. It reveals that IoT technologies excel in data acquisition and transformation into knowledge, a fact supported by the strong consensus among employees regarding their capacity to acquire knowledge. Regarding storage, there are no inherent limitations in size. However, it is observed that explicit knowledge is more straightforward to store, whereas implicit knowledge presents challenges in this regard. Additionally, knowledge sharing through IoT technologies displays variability and limitations across different companies, resulting in varying perspectives on the efficacy of knowledge sharing within their organizations. Nonetheless, knowledge derived from IoT technologies finds versatile applications, with most companies acknowledging its value and ease of comprehension, contributing to the enhancement of internal processes and overall organizational performance.

Organizational Performance: Internal Process. Integrating IoT technologies into the knowledge management process significantly impacts corporate operations. This impact is evidenced by the enhanced accessibility of essential information for employees, resulting in increased productivity in their tasks. Additionally, it is underscored by the capabilities arising from the transformed Knowledge Management, including real-time sharing, and streamlined access with improved security measures.

It is worth noting that some organizations employ a filtering approach, as revealed in interviews, and focus group discussions. In these cases, middle and top-level managers believe

that this approach helps reduce information overload and allows team members to maintain focus on their specific tasks. The knowledge gathered can vary depending on the industry; however, there are notable similarities among companies using IoT technologies for marketing purposes across different sectors. These organizations concentrate on extracting customer insights to derive management benefits, foster innovation, and enhance strategic planning.

Therefore, while the type of knowledge required may vary based on the industry, the overarching consensus is that IoT-facilitated knowledge is generally understandable and provides valuable insights, benefiting organizations across diverse sectors.

Conclusion

The data analyzed in this study strongly supports both propositions. The data supporting Proposition 1 (P1) shows that businesses use technologies well, particularly when it comes to middleware usage and data presentation, which are crucial steps in the knowledge-creation process. Although the specific application may vary depending on a company's needs, the uniformity of hardware devices like computers and tablets emphasizes their importance.

The data analysis, which demonstrates how the knowledge management process affects various aspects of operations, also supports Proposition 2 (P2). Companies have notably enhanced efficiency and convenience in acquiring knowledge, enabling communication both internally and externally through real-time sharing. This achievement was made while ensuring security measures to protect collected and stored knowledge among team members.

The empirical evidence from this study aligns with the current literature and strengthens both propositions, underscoring the role of IoT technologies in optimizing knowledge management processes and improving organizational efficiency.

This research has provided insights into the range of technologies utilized by various companies. It highlights differences in software applications while also noting similarities in hardware such as computers and tablets. Some notable examples of software include outsourced solutions such, as Uvibilox, Google Workspace, Grab Merchant, and POS Systems. Additionally, companies may choose to invest in in-house solutions for their loyalty programs or automate video ingestion from their YouTube pages. These IoT software solutions are designed to cater to the specific data presentation needs of each company, considering factors like company size and industry.

The integration of IoT varies across organizations. Has impacts on knowledge management processes. The extent of this impact depends on factors like industry dynamics, company size, and organizational culture. While IoT technology plays a role in all knowledge management processes, its influence is particularly significant when it comes to knowledge storage and utilization. The quality of knowledge sharing, whether facilitated by IoT or not, greatly affects these processes.

The impact on performance is notable when it comes to processes. The affected knowledge management processes contribute to efficiency and convenience within the organization. Real-time sharing capabilities offered by technologies enhance efficiency and promote better utilization of knowledge resources. Moreover, the ability of the IoT to store information empowers organizations to optimize their products and services using data.

Therefore, it can be concluded that IoT technology acts as a catalyst for enhancing knowledge management processes by enabling real-time data production, storage, sharing, and utilization. This increase in knowledge processing leads to improved decision-making and the possibility of higher customer satisfaction. In the end, incorporating technology proves to be a resource for companies aiming to optimize their knowledge management and overall performance.

Declarations

None of the authors see a conflict of interest in examining the cases presented in the study. Artificial intelligence, particularly large language models, was used solely to improve the grammar, syntax, and readability of the paper.

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