AI Technology in J.P. Morgan Chase & Co.

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1. An Introduction to the Evolution of Industry 4.0

Mechanical production, powered by engines, was the most important sign of the first industrial revolution that came about in the eighteenth century. In the Industry 1.0 almost every aspect of people's lives changed when societies witnessed unexpected growth in population, income levels and standard of living for the general population (Groumpos, 2021). However, in the second industrial revolution, the manifestation of electricity fostered the evolution of large-scale manufacturing, and many technological systems such as railway networks, gas and water supply, and inventions, including the telephone and radio. This, in turn, accelerated urbanization growth. Subsequently, the industry transitioned to automated production using computers (Taalbi, 2019; Groumpos, 2021). The transition from analog technology to digital technology fundamentally changed the way people work, produce, and entertain, particularly in the areas of communication and energy. This shift has given rise to the sharing economy and introduced the internet which has had a profound impact on societies (Rifkin, 2011). Industry 4.0, the current revolution we are experiencing, is about the virtualization and connectivity of smart industrial objects. This transformation involves the integration of diverse technologies, such as Artificial Intelligence (AI), Internet of Things (IoT), and other emerging advanced technologies (Culot et al., 2020; Javaid et al., 2022). This revolution optimizes the value chain, demonstrating a dedication to sustainable practices and delivering environmentally friendly, intelligent, efficient, and personalized production while upholding cost-effectiveness (Kamble et al., 2018; Cividino et al., 2019; Mehdiabadi et al., 2020).

The utilization of Industry 4.0 technologies has the potential to positively contribute to corporate social responsibility and improve environmental performances for instance, by minimizing waste, and preventing detrimental emissions (Grybauskas et al., 2022; Morrar et al., 2017). Despite Industry 4.0 leading to a reduction in human work in certain occupations, it has simultaneously generated new jobs under the Coronavirus Pandemic in particular industrial domains. It provides solutions to sustainability challenges, including demographic aging, escalating demands for food, and waste management. However, challenges such as the lack of strategic planning in the Industry 4.0 technologies' adoption, limited awareness regarding their ethical and sustainable production contributions, and insufficient support from managers exist. If not managed properly, the ripple effect could result in negative transformative impacts on society (Pozzi et al., 2021; Kumar et al., 2020; Machkour and Abriane, 2020).

2. AI Technology

Artificial Intelligence (AI) is a key driver in the recent progress of Industry 4.0. Rapidly delivering benefits and efficiencies to organizations globally, its adoption rate is steadily increasing at more than 35%, compared to 31% in 2021 (IBM Corporation, 2022). Although AI has great potential in tackling major societal and sustainability issues—such as Supporting personal habits to minimize energy requirements or automating the collection and management of climate related data—simultaneous challenges exist, like income inequality and job displacements (Rawashdeh, 2023; Nishant et al., 2020). While using AI, there is a reliance on historical data; risks of cybersecurity are high, human behavioral responses to AI based intermediaries are unpredictable, and there are plenty of adverse impacts of AI applications, such as ethical concerns, privacy violations, and potential biases that require appropriate consideration and management (Nishant et al., 2020). An example of AI's impact on the environment is that The carbon emissions generated during BLOOM's training are 25 times greater than those produced by a solo air traveler on a one-way trip covering 2600 miles (Luccioni et al., 2022). AI has entered its era of deployment known as Generative AI, capable of generating original content by leveraging the knowledge from its

training dataset. Recently released Generative AI tools, including ChatGPT and DALL-E 2 (Figure 1), demonstrate enhanced capabilities in tasks such as speech recognition, text manipulation and analysis, question answering, and image and code generation from natural language descriptions. These tools have made this technology widely available, attracting global attention (Maslej et al., 2023; Schaeffer, 2023). "generative AI reduces the money and time needed for content creation across text, code, audio, images, video and combinations thereof," said Gokul Hariharan, Co-Head of Asia Pacific Technology, Media and Telecom Research at J.P. Morgan (JPMorgan Chase & Co., 2023a). Despite its vast potential, Generative AI models pose numerous risks. For instance, they can be employed to compose and disseminate spam emails or robocalls at a pace far exceeding human capabilities. Additionally, hackers can craft prompts to manipulate Generative AI models, leading to the inadvertent sharing of confidential data or the disclosure of proprietary information (The Wall Street Journal, 2023; Fui-Hoon et al., 2023).

	WRITER	CODER	VISUAL ARTIST	MATHEMATICIAN
Applications	• OpenAI GPT-3* (2020) and GPT-4* (2023) which power ChatGPT • Google PaLM* (2022) and PaLM 2* (2023) • Anthropic Claud 2* (2023)		• OpenAI DALL-E (2021) • Midjourney (2022) • Stable Diffusion (2022)	• Google Minerva* (2022)
Capabilities	Writes novel, high-quality responses to prompts that are often indistinguishable from human writing. It can write a college essay, explain a joke, summarize a book, or help draft an email.	Writes functional code in various languages from a specification. For existing code, it can explain, debug, and analyze (e.g., calculating time complexity).	Creates high-quality images—photorealistic or artistic—based on written descriptions. Early progress has also been made on generating video.	Solves complex numerical problems at the college level in subjects including algebra, physics, number theory and machine learning.

Figure1: Showing different Generative AI's Applications and Capabilities (Source: Aliaga and Albrecht, 2023: Online)
*GPT-3, GPT-4, Pa'LM, PaLM 2, Claud 2, and Minerva are all large language models (LLMs).

This progress is recognized as the emerging forefront across different sectors, including the banking industry. Personalized services, smart wallets and customer and transactional security are examples of the potential opportunities. Banking regulators actively endorse utilization of AI through legal measures and cooperation. Despite its profound potential, the full impact of Generative AI on diverse professions and industries may not be fully understood for years to come. Key stakeholders in the industries must therefore develop effective strategies to address both existing and potential challenges posed by AI (Ghandour, 2021; Generative AI: A Creative New World, 2023).

In order to analyze the influence of the adopted AI technology on J.P. Morgan Chase & Co., this report utilizes the Business Model Canvas framework (Osterwalder and Pigneur, 2010). The framework illustrates how an organization creates, captures, and delivers value through its products or services (Toro-Jarrín et al., 2016). Internally adopted AI has significantly impacted key elements of the business model, including key activities, resources, value proposition, and cost structure. Furthermore, recommendations are provided based on potential issues related to the technology and existing capabilities.

3. J.P. Morgan Chase & Co. History

J.P. Morgan Chase & Co. is a dominant financial company rooted in the United States. Employing over 240,000 individuals, it operates in more than 60 countries worldwide (JPMorgan Chase & Co., 2023c). According to its 2023 Annual Meeting of Shareholders, J.P. Morgan Chase reported its assets totaling $3.7 trillion and stockholders' equity amounting to $303 billion at March 31, 2023 (2023b). It was founded in 1799 and has evolved with roots in the legacy of 1,200 organizations. Some notable heritage firms include

JPMorgan Co., Bank One, The Chase Manhattan Bank, and The First National Bank of Chicago. Each of these companies, in its time, contributed substantially to financial advancements (JPMorgan Chase & Co., 2023c).

As part of its key resources in the Business Model Canvas, J.P. Morgan Chase is committed to enhancing the processes involved in creating high-quality software and innovative products, including design, analytics, development, coding, testing, and application programming. The company, with a global team of over 55,000 technologists and an annual investment of $14 billion in technology, emphasizes its commitment to technological advancement (Green, 2022).

They developed Carbon Compass[SM] and aim to align crucial segments of their financing portfolio with zero carbon footprint before 2050 to reduce the emission levels in their investments gradually within specific domains. Moreover, their objective is to channel above $2.5 trillion towards tackling global warming and promoting sustainable growth by the end of 2030. J.P. Morgan Chase & Co. defines its mission as follows: 'Inclusive Growth. To enable more people to share in the rewards of a growing economy' (JPMorgan Chase & Co., 2023d).

4. Drivers of AI in J.P. Morgan

Considerable discourse has been dedicated to the developments in artificial intelligence (AI) and how they affect the economy, employment, and productivity. As AI becomes an inseparable component of the banking industry, institutions must differentiate their services by ensuring they offer value beyond technological aspects. J.P. Morgan, as the world's largest bank, is no exception. The importance of convenience and accuracy in analyzing and interpreting substantial volumes of market data for banks has increased (Thowfeek et al., 2020). Moreover, with advancement in technology, customers increasingly expect AI to deliver greater convenience and personalized services, providing them with enhanced protection, savings, and the ability to make informed decisions (JPMorgan Chase & Co., 2023b). In addition to all the mentioned factors, enhancing the experience of key personnel, including portfolio managers, improving customer interactions and minimizing obstacles for end users may play a crucial role in the transformation of AI within the banking sector (Mejia, 2019). Therefore, considering all the aforementioned factors, in an era where artificial intelligence increasingly dominates the financial landscape, J.P. Morgan is taking a significant step forward by investing more than $15 billion in technology in 2023 This investment underscores the pivotal role of technology as a key resource for the firm. An essential element of J.P. Morgan's strategy involves making investments in data, machine learning, and AI (Huang and Grady, 2022; Leffert, 2023). At the Global Technology segment of Investor Day held on May 22, 2023, Beer, the Global Chief Information Officer (CIO) of J.P. Morgan Chase & Co., emphasized the significance of AI, particularly GPT and large language models. She acknowledged the capabilities of these tools, underscoring the firm's dedication to exploring various applications that can deliver value (JPMorgan Chase & Co., 2023e).

5. J.P. Morgan Investments in AI and its Impacts

Key Activities

J.P. Morgan is currently developing an artificial intelligence service, similar to ChatGPT, named IndexGPT. The goal is to introduce an investment advisory service that utilizes data to assist users in optimizing returns (Ramlochan, 2023; Son, 2023). Although AI advisory models have been present for more than a decade, with the first robo-advisor, Betterment, starting in 2008, the widespread success of OpenAI's technology in 2022 prompted entire industries to address the reality of artificial intelligence. In this context, banks are actively seeking to capitalize on this opportunity. For instance, Bank of America recently introduced its virtual service adviser, CashPro Chat (Bank of America, 2023). Simultaneously, developing IndexGPT, aligns with J.P. Morgan's overarching strategy, emphasizing Generative AI to maintain its prominent position in the banking sector and enhance customer service (Ramlochan, 2023; Son, 2023). Integrated into the Chase application, this service provides a user-friendly platform for managing long-term investments for existing clients. This development has heightened concerns among financial advisors regarding the potential displacement of their roles by technology. While financial management companies, such as Morgan Stanley and Bank of America's Merrill, offer straightforward robo-advisor services, IndexGPT holds the potential to enhance services by providing round-the-clock assistance and personalized portfolio recommendations, potentially improving the accuracy of market data analysis for data-driven investment decisions. Despite its potential, IndexGPT is more expensive than other robo-advisors, potentially making it less appealing than similar products from competitors. Additionally, the extensive use of data in machine learning algorithms is consistently associated with risks related to privacy and security when using these products (Dignan, 2023).

Furthermore, J.P. Morgan's AI Research team has identified various methods for generating synthetic data sets using Generative AI, tailored to different data types. This contribution aids the advancement of AI research in finance, particularly when access to real data is limited or more varied data is needed. For instance, in deep fake detection, defensive AI models often face challenges. Generative AI helps train Large Language models with broader, more varied data, to ensure that simple adjustments do not bypass them. Through AI model training, the firm has achieved significant progress in fraud detection, where models learn to identify suspicious transaction patterns by analyzing examples of both normal and fraudulent transactions. Using these approaches, J.P. Morgan's synthetic datasets include information on activities related to Anti-Money Laundering (AML), customer journey events, market execution data, and payment data, designed for fraud detection purposes (Samuel et al., 2020; JPMorgan Chase & Co., 2022h).

Despite the numerous potentials that AI offers, it also poses significant risks and concerns, particularly in the financial sector. For instance, there is the question of whether AI systems can act solely in the customer's best interest. Another example is algorithmic collusion, where Artificial Intelligence systems learn and participate in anti-competitive behaviors. Additionally, there are risks related to the health of the economic system. AI Financial Advisory assistants, such as IndexGPT, could lead to market instability or incidents if algorithms implicitly follow similar trading strategies (Ishani Majumdar, 2019). Moreover, large language models use extensive amounts of data for training, and deep-seated social inequalities are part of this raw data, presenting a constant risk of biases in AI decision making, such as unfair credit, loan, and insurance outcomes. JPMorgan Chase & Co. stands out as one of the few banks with a strategic focus on transparent and Responsible AI (RAI). The bank has demonstrated its commitment to RAI by

establishing leadership roles, publishing ethical principles and AI reports (Evident Insights Ltd., 2023). RAI involves principles, policies, tools, and processes to ensure the development and functioning of AI systems benefit individuals and society, while achieving positive impacts (Cheng et al., 2021). The Global Chief Information Officer (CIO) of J.P. Morgan Chase & Co. has underscored their commitment to the responsible use of AI, emphasizing the engagement of a diverse team, including ethicists, data scientists, AI researchers, and other experts. This team plays a crucial role in assessing risks, implementing suitable measures to avert unintentional misuse, ensuring regulatory compliance, and establishing trust among customers and communities (JPMorgan Chase & Co., 2023e).

Key Resources

The bank boasts an impressive team, including over 900 data scientists, 600 machine learning engineers, and around 1,000 individuals dedicated to data management, and a cutting-edge 200-person AI research team addressing the most difficult problems in the emerging frontiers of finance (JPMorgan Chase & Co., 2023f) (Figure 2).
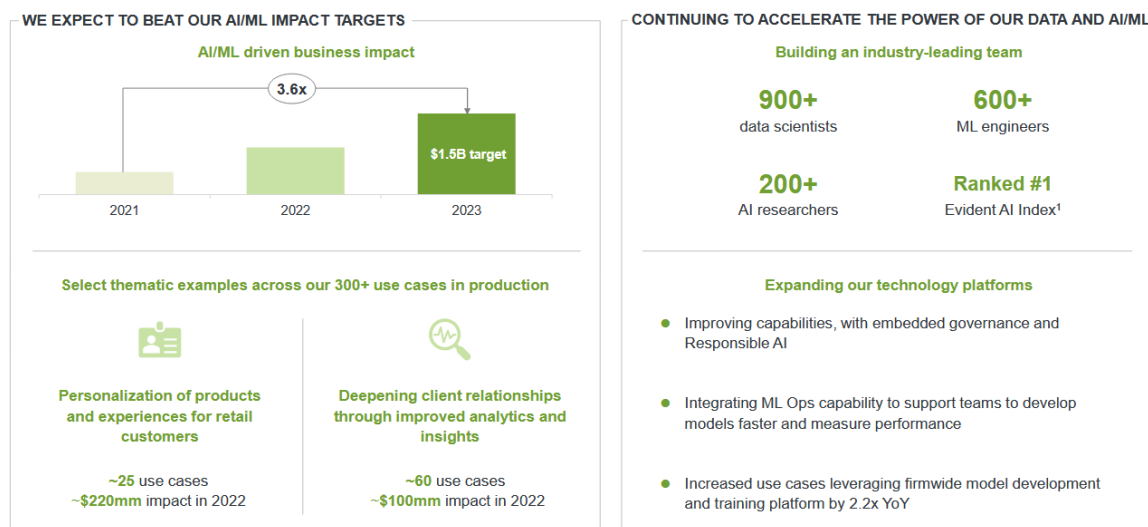

Figure 2: illustrates the information and progression of J.P. Morgan through its investment in AI (Source: J.P. Morgan Chase & Co., 2023: Online)

Customer Relationship

The firm aims to use Generative AI to improve 'know your client' (KYC) processes and assist call center agents in promptly understanding customer conversations, offering timely solutions to issues.

J.P. Morgan's Corporate & Investment Bank utilizes machine learning to customize the digital interactions on its platform, 'J.P. Morgan Markets'. In this platform, every client logs into a personalized portal that delivers distinctive research tailored to their specific requirements (JPMorgan Chase & Co., 2023e; Pinto, 2023). J.P. Morgan Chase possesses the capability to leverage 500 petabytes of data, applying training methodologies, enhancing data quality, and contributing value to open-source models (Dignan, 2023).

Moreover, J.P. Morgan is the first bank that has implemented an AI-driven virtual assistant. J.P. Morgan's virtual assistant empowers users to request real-time information, such as account balances and ensures a unified customer service experience across multiple channels. Moreover, the virtual assistants evolve

with clients' interactions, providing personalized and valuable recommendations while also optimizing internal processes by addressing common questions (JPMorgan Chase & Co., 2023g).

In addition to the aforementioned, J.P. Morgan utilizes advanced AI models for payment validation screening, offering clients insights such as cash flow analysis and enhancing processing speed by reducing false positives. This improvement optimizes queue management, resulting in decreased fraud levels and an improved customer experience. Notably, the implementation has led to a 15-20% reduction in account validation rejection rates (Samuel et al., 2020; JPMorgan Chase & Co., 2022h).

Cost Structure

The firm assesses value through precise tracking of costs and returns associated with its investments. Initially, Beer stated a goal of creating $1 billion in value through AI by the conclusion of 2023. However, due to recent results, the bank has increased its target. J.P. Morgan now anticipates that its investments in data analytics and AI, particularly for improving the customization of services for customers, will yield $3 billion in cost savings and efficiencies across infrastructure and data initiatives, in addition to creating $1.5 billion in value through AI by the end of 2023. Furthermore, it is projected that the ongoing infrastructure modernization—which is considered to be the most significant step toward the successful implementation of AI targets—will generate an extra $1.5 billion in savings and operational efficiencies in the next three years. Applications, infrastructure and engineering are three fundamental aspects of modernization strategy (Leffert, 2023).

AI is closely linked to cloud-based systems and digital capabilities. The latest AI strategies has enhanced the efficiency of native cloud-based approaches, making them faster and more cost-effective. Moreover, modernizing infrastructure involves data centers optimization and applications migration to clouds. The company has invested over $2 billion in constructing new, cloud-based data centers and is actively modernizing a substantial portion of its applications, including related databases, to operate in both public and private clouds. These approaches provide convenient access to continuously evolving developer tools. As of the end of 2022, approximately 38% of their applications have been migrated to the cloud, resulting in over 50% of their application portfolio running on modern environments (JPMorgan Chase & Co., 2023e). As a result of infrastructure and application modernization and utilization of Software-as-a-Service (SaaS), the team's speed in product delivery increased by 20% compared to 2022. By the end of 2023, 60% of tools are going to migrate to SaaS and this will enable the firm to expand the reach of new products to over 240,000 employees rapidly. By the end of 2026, J.P. Morgan expects to achieve about 80% modern infrastructure (Crosman, 2023; JPMorgan Chase & Co., 2023e).

The modernization efforts in engineering involve the provision of tools and abilities to empower 43,000 engineers, augmenting overall productivity. J.P. Morgan initially aspired to achieve an 80% enterprise tool chain's adoption rate by the conclusion of 2022. Surpassing this target, they have reached 84%, with a further plan to attain full adoption by the end of 2023. Furthermore, the evaluation of engineering excellence employs a productivity framework, systematically measuring performance across speed, agility, and stability dimensions. A significant proportion, specifically 60%, of the team members have embraced agile methodologies and measurement frameworks. Moreover, the progression of transitioning features from backlog to production has seen an annual improvement of 20%. Consequently, the organization has experienced a notable annual increase of 60% in the volume of implemented changes. Modernization and its outcomes are critical for J.P. Morgan, as the company strives to further

expand its capabilities in artificial intelligence (AI). These outcomes can be regarded as indirect effects of the company's AI strategies on its cost structure, resulting in substantial savings (Pinto, 2023).

Value Proposition

J.P. Morgan has recently secured the top position on the Evident AI Index, the first public benchmark of major banks on AI maturity (2023). Furthermore, the bank currently operates more than 300 AI use cases in risk management, marketing, user experience, detecting and preventing fraud and other areas (JPMorgan Chase & Co., 2023e).

Moreover, J.P. Morgan's AI strategy, in conjunction with modernization, has significantly influenced the operations of its payment systems. Graphite, currently ranked the third-largest in terms of transaction volume, has been impacted by AI implementations at J.P. Morgan (JPMorgan Chase & Co., 2023e). This scalable and modern strategic platform has revolutionized global payment processing, with a notable focus on real-time payments. Each payment capability within Graphite is constructed with its own independent component architecture, enhancing efficiency and adaptability. Previously, the Bank required 18 months to launch a new real-time payment market. However, due to recent advancements, this timeframe has been significantly reduced to a range of three to six months (Solaimani et al., 2023; PYMNTS, 2023).

Revenue Streams

In 2022, J.P. Morgan dedicated approximately $14.3 billion to technology expenditures. This investment has proven to be fruitful in retail banking, mitigating risks by reducing fraud and illegal activities, and generating $220 million in revenue through personalized offerings such as credit card upgrades. They anticipate concluding the year 2023 with a total expenditure of $15.3 billion (Figure3), attributed to heightened volumes, wage inflation, and targeted investments, primarily in the Consumer & Community Banking (CCB) segment (Dignan, 2023; Crosman, 2023).

J.P. Morgan Asset Management predicts potential productivity increases ranging from 1.4% to 2.7% over the next decade through the implementation of generative AI and other AI technologies. This is in addition to the anticipated 1.5% annual productivity growth forecasted by the Congressional Budget Office (Aliaga and Albrecht, 2023).
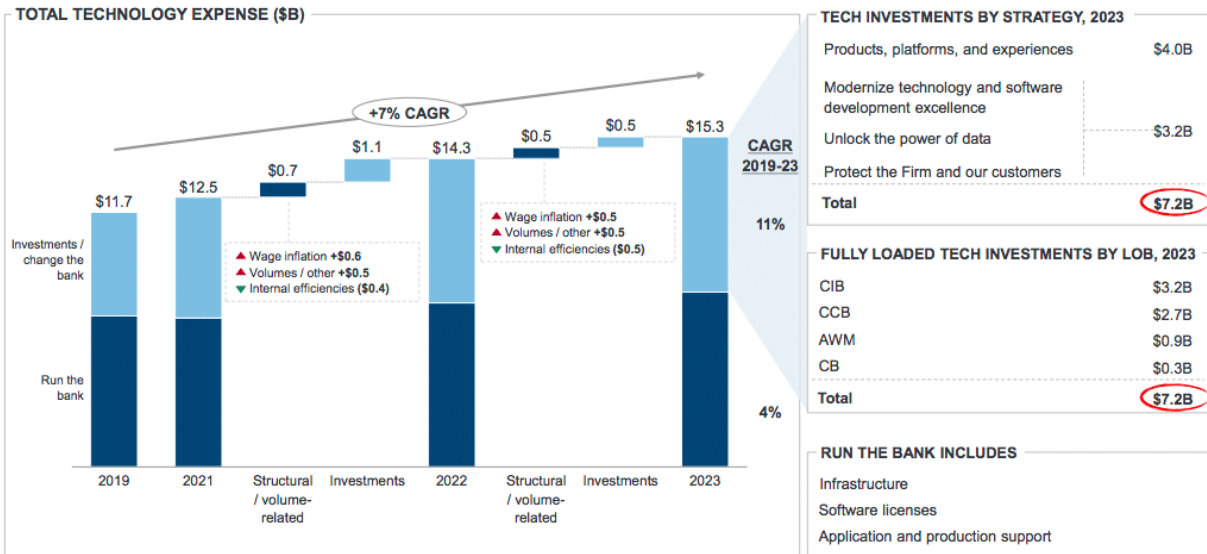
TOTAL TECHNOLOGY EXPENSE ($B)

+7% CAGR

$11.7 — 2019
$12.5 — 2021
$0.7 — Structural / volume-related
$1.1 — Investments
$14.3 — 2022
$0.5 — Structural / volume-related
$0.5 — Investments
$15.3 — 2023

Investments / change the bank
Run the bank

▲ Wage inflation +$0.6
▲ Volumes / other +$0.5
▼ Internal efficiencies ($0.4)

▲ Wage inflation +$0.5
▲ Volumes / other +$0.5
▼ Internal efficiencies ($0.5)

CAGR 2019-23
11%
4%

TECH INVESTMENTS BY STRATEGY, 2023

Products, platforms, and experiences	$4.0B
Modernize technology and software development excellence	
Unlock the power of data	$3.2B
Protect the Firm and our customers	
Total	**$7.2B**

FULLY LOADED TECH INVESTMENTS BY LOB, 2023

CIB	$3.2B
CCB	$2.7B
AWM	$0.9B
CB	$0.3B
Total	**$7.2B**

RUN THE BANK INCLUDES

Infrastructure
Software licenses
Application and production support

Figure 3: illustrates J.P. Morgan's investment in technology from 2019 to 2023 (Source: J.P. Morgan Chase & Co., 2023: Online)

6. Conclusion and Recommendations

AI advancements have the potential to displace jobs, and it is essential to achieve a balance between technological progress and ethical considerations (Pringle, 2023). To achieve successful Responsible AI initiatives, its principles must be ingrained in the organization's culture, rather than just added as a technical requirement. Implementing these cultural shifts demands the appropriate skills and mindset. It is highly recommended that J.P. Morgan, as an organization committed to Responsible AI (RAI), actively contribute to the creation of educational opportunities for individuals whose job positions are at risk due to AI. This initiative presents a mutually beneficial opportunity for both individuals and the industry, facilitating the redeployment of employees into more productive roles.

Healthcare remains behind in digitization when compared to other industries, in financial investments as well as the use of technology for business processes and payments. Therefore, introducing AI-powered payment solutions has the potential for banks to benefit from the healthcare industry and to enhance the healthcare ecosystem as well. As an additional recommendation, novel digital payment channels can intelligently incorporate transactions to enhance the overall healthcare services' delivery. AI-based systems have the potential to assist patients in better budgeting and optimizing their expenditures by monitoring their health needs over time and predicting potential future expenses.

Furthermore, AI has played a crucial role in the payment industry by enabling the analysis of diverse data points and real-time risk assessment, effectively addressing challenges associated with credit scoring. This can be considered as an opportunity for banks to develop customized solutions for patients, presenting various payment options such as splitting bills into multiple parts or providing 'Use now; Pay later' solutions based on their credit score. These approaches simplify the payment process and enhance the financial flexibility of healthcare recipients.

Appendix

J.P. Morgan Chase & Co. Business Model Canvas				
Key Partners	**Key Activities**	**Value Propositions**	**Customer Relationships**	**Customer Segments**
*Subsidiaries (J.P. Morgan, Chase,...) *Sponsorships *Shareholders *Technology Companies *Financial Institutions	*Retail Banking *Financial Advisory *Financial services for consumers and small business **Key Resources** *$3.7 trillion assets *$303 billion stockholders' equity *240,000 employees *Operates in more than 60 countries worldwide	* Largest Bank in the United states *The most valuable bank by market capitalization in the world * One of only 3 banks with a strategic focus on transparent and Responsible AI * Customized financial services to individual consumers via retail banking *Convenient and comprehensive range of investment banking *Tailored financial solutions to businesses *Leader in commercial banking, financial transaction processing and asset management	*In 100+ global markets *200 years of service *Personalized Services and dedicated advisory **Channels** *Branches *ATMs *Online and Mobile banking	*Individuals *Institutional and government clients *Small businesses and many of the world's most prominent corporate clients
Cost Structure			**Revenue Streams**	
*Taxes *Staff *IT Platform development and maintenance *Operation centers			*Interest *Service fees *Return on investment portfolio *Commission on services	

J.P. Morgan Chase & Co. Business Canvas Model

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