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Navigating Complexity: Logistical Lessons from 15th-Century Maritime Explorations

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ABSTRACT

This article offers a fresh analysis of 15th-century maritime explorations through the lens of large-scale project management. By detailing the critical stages of these expeditions, from shipbuilding and recruitment to provisioning essential supplies, it highlights the ingenuity, meticulous planning, and organizational expertise of navigators in the face of extreme challenges. The author explores the efficient management of scarce resources, such as water and food, and examines how adaptability to unexpected events—storms, diseases, navigational errors, and equipment failures—enabled explorers to overcome the hardships of long ocean crossings. In a unique and thought-provoking manner, the article draws parallels between the logistical practices of 15th-century navigators and those used in managing complex 21st-century projects. This cross-disciplinary approach underscores the continued relevance of historical lessons for addressing modern logistical challenges, particularly in uncertain, volatile, and turbulent environments. Ultimately, the article stresses the importance of ethics in large-scale project management, reminding scholars that innovation and progress must prioritize human dignity, environmental sustainability, and long-term social responsibility.

Keywords: Ethics, History, Innovation, Logistics, Maritime explorations, Project management, Resources, Supply chain, 15th century.

INTRODUCTION

15th-century maritime explorations were an ambitious undertaking, requiring considerable investments of time, resources, and funding [16]. These ventures unfolded against a backdrop of intense competition among European powers, each seeking to expand their territories, trade networks, and religious influence. Financing such expeditions was often a cornerstone of these efforts, involving key decisions by monarchs such as Isabel of Castile and Ferdinand of Aragon, who sought to recoup their initial outlay through the discovery of new trade routes, valuable merchandise, or symbolic gains tied to the spread of Christianity [26]. Christopher Columbus secured the support of the Spanish sovereigns by promising them access to riches from Asia and the conversion of the peoples he encountered. In addition to royal patrons, merchants and bankers, motivated by the prospect of substantial profits, invested in these ventures in exchange for shares in the returns or control over new trade routes. These alliances between crowns and private capital reveal the pragmatic, commercial dimension of the great explorations, contrasting with the more romanticized narratives of quests driven solely by glory or faith.

The history of the great maritime explorations of the 15th century provides valuable insights into large-scale project management practices. These bold adventures, led by iconic figures such as Vasco da Gama, Christopher Columbus, and Magellan, not only reshaped the geographical and economic landscape [17], but also established logistical and organizational methods that continue to resonate across various economic and industrial sectors today. The maritime explorations reveal challenges familiar to modern managers: the mobilization of human and material resources, risk management, decision-making under uncertainty, innovation in uncharted environments, and the anticipation of unforeseen events. Indeed, the large-scale maritime expeditions of the 15th century required meticulous preparation, careful management of limited resources, and exceptional adaptability in the face of the unpredictable conditions encountered during ocean crossings. These challenges mirror those faced by 21st-century companies, which must constantly innovate and adapt to meet the pressing demands of their time.

The importance of reflection is not merely academic but also practical, offering timeless lessons that can enhance project management. The logistical challenges faced by 15th-century explorers remain highly relevant in the current globalized and interconnected world. Yet, while numerous studies explore the history of the great maritime explorations of the 15th century, few investigate how ancient practices can be applied to modern project management. Notable exceptions, such as the contribution by Hakamian *et al.* [11], stand out for their rarity and insight. The existing literature remains limited, particularly in drawing analogies between historical and contemporary approaches to crisis management, cost-efficiency, and organizational flexibility. The contribution seeks to address this gap by examining how the logistical and organizational strategies of 15th-century maritime explorations can inform contemporary challenges. Adopting an interdisciplinary approach, it aims to foster a constructive dialogue between history and management, demonstrating how key lessons from past maritime expeditions remain relevant to present-day's decision-makers navigating increasingly uncertain, volatile, and turbulent environments.

This exploratory article is structured into four sections. The first section underscores the critical importance of meticulous preparation, detailing the essential steps for successful 15th-century maritime expeditions, from shipbuilding to crew provisioning. The second section examines resource management in extreme conditions, illustrating how navigators of the period optimized the availability of food and fresh water to overcome the challenges of prolonged ocean crossings, particularly under time constraints. The third section analyzes adaptability in the face of unforeseen events, exploring the strategies implemented to address maritime hazards such as storms, damage, and disease. The fourth section delves into the key lessons drawn from 15th-century maritime explorations, drawing parallels with the management of contemporary large-scale projects, especially in global supply chains, innovation, and resilience against health and geopolitical crises. This original comparative analysis highlights the potential enduring relevance of historical principles for 21st-century businesses.

PREPARATION

The 15th century in the West was marked by the rediscovery of Ptolemy's treatise on geography [5], which reinforced the belief that the world was round. Armed with the latest

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compasses, astrolabes, quadrants, and declination tables, sailors set sail on caravels, ships designed for long-distance voyages. The social and political evolution of Europe soon positioned the Netherlands and England as the two great Western maritime powers, as English and Dutch vessels were significantly faster and more maneuverable than Iberian caravels, whose weight was a major drawback (2,000 tons, compared with 300 tons for caravels) [6]. The growth of maritime trade fueled increasing interest in ocean routes and, above all, in the mapping and study of geography. Baffin Bay, Hudson Bay, the coasts of the Barents Sea, and New Zealand were discovered and, in some cases, meticulously mapped. While this period of exploration is often associated with Western powers, it is important to note that numerous significant explorations were also carried out at the instigation of the Chinese Emperor Ming Yung Lo during the 15th century [25].

The success of 15th-century maritime explorations depended largely on meticulous preparation, which was crucial for overcoming the logistical challenges of long voyages in often unpredictable conditions. Shipbuilding, as a key initial challenge, was essential for ensuring both safety and speed, and Portugal's expertise in this area played a significant role in the country's maritime expansion [14]. Caravels, a major technical innovation of the time, featured a design that combined triangular sails—ideal for maneuvering against the wind—and square sails, optimized for navigating the high seas. Strong, maneuverable, and capable of carrying substantial cargo, caravels met the needs of explorers and traders alike, but their construction required vast amounts of material and human resources. The ships' structure was primarily made of wood, with iron used for nails and tools. A wide range of specialized craftsmen—carpenters, sailmakers, blacksmiths, and caulkers—worked collaboratively, often for months, to complete each vessel [7]. This process required significant investment, including the formation of crews, typically comprising 170 to 180 men, often funded by patrons or governments, as in the case of Christopher Columbus, whose expeditions were supported by Isabel of Castile and Ferdinand of Aragon.

Procurement was the second logistical challenge in preparing for sea explorations. Not only did the food need to be sufficient for long crossings, but it also had to withstand harsh conditions. Sea biscuit, a hard, dry bread, formed the basis of the crew's diet, supplemented by salted fish, smoked pork, legumes, cheese, and sometimes dried fruit. While these foods were convenient for storage, they did little to prevent nutritional deficiencies, particularly scurvy, caused by a lack of vitamin C—referred to by Lamb [12] as "the disease of discovery." Freshwater, stored in barrels, was also essential, though its rapid deterioration posed significant health risks. To address this, sailors were forced to collect rainwater or resupply in ports during stopovers. Additionally, wine and beer were carried on board, as they kept better, provided some nutritional value, and helped maintain crew morale. Finally, ships were stocked with repair materials such as planks, tar, and ropes to address damage at sea, as well as weapons to defend against pirate attacks, conflicts with local populations, or even potential mutinies. This multi-faceted approach to procurement demonstrated an adaptive strategy to ensure survival in a hostile environment.

The third logistical challenge is crew recruitment. Long-distance maritime exploration demands experienced sailors and skilled personnel across various fields. Crews included not only specialized sailors, such as helmsmen and topmen, but also carpenters for repairs at sea,

cooks to prepare rations, and soldiers to ensure the safety of the ships and their passengers. Interpreters and scribes were also crucial for establishing communication with local populations and documenting discoveries. The diversity of these crews is notably depicted in several medieval illuminated manuscripts [9] (see Figure 1). Explorations were extremely risky, and this reality often discouraged many potential candidates from joining such expeditions. As a result, crews were often composed of volunteers from modest backgrounds, attracted by promises of material gain, glory, land, or adventure. The challenge of finding qualified men who were loyal to the project, amidst the multiple dangers and harsh living conditions, was significant. Exploration managers also had to manage tensions among crew members in extreme situations, making this a critical aspect of 15th-century maritime explorations.

Figure 1: Diversity of crew members on a caravel
Source: Museum of the Forte da Ponta da Bandeira, Portugal (CC BY License, 2006).

Organizing the three dimensions—construction, procurement, and recruitment—demands meticulous planning, as any error or omission can jeopardize the success of maritime exploration, potentially resulting in significant loss of life, resources, and property. The primary strength of explorers lay in their capacity to learn from previous voyages, continuously refining their preparations based on accumulated knowledge and firsthand experience. They carefully adjusted the quantities of foodstuffs, optimizing limited storage space while ensuring provisions would not be depleted during long crossings. The selection of skilled craftsmen and navigators aimed to guarantee not only the quality of shipbuilding but also the overall performance and adaptability of the crews. Additionally, they fine-tuned logistical strategies to optimize routes, reduce crossing times, and mitigate the risks posed by unpredictable sea conditions, particularly storms and strong currents. This rigorous preparation, honed over decades and spanning multiple successful expeditions, allowed renowned navigators to push

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the boundaries of the known world, paving the way for transformative discoveries that reshaped global trade networks and altered the course of human history.

NAVIGATION

Navigation at sea during the great explorations of the 15th century was a bold and ambitious endeavor, characterized by significant technical, human, and environmental challenges. Explorers of the era had to rely on rudimentary instruments and empirical knowledge to traverse largely uncharted oceans and reach destinations that were sometimes more speculative than precise. The compass, in use in Europe since the 12th century, played a critical role in orienting ships by indicating the direction of magnetic north [13]. When combined with the astrolabe, which measures the height of stars above the horizon to approximate latitude, it became an essential tool for high-seas navigation. Additionally, portolan charts, which detailed coastlines and identified key ports, provided pilots with a visual representation of known sea routes, helping to guide the selection of travel paths and improve overall navigation accuracy. However, these instruments had limitations, particularly when it came to determining longitude, leading to navigational errors, unforeseen detours, and considerable discrepancies between planned and actual routes.

The tools available to explorers had to be complemented by a largely empirical understanding of winds and currents. For instance, Christopher Columbus relied almost instinctively on the trade winds to sail westward across the Atlantic and used the westerly winds for his return journey to Europe [28]. These predictable, consistent winds provided explorers with a unique opportunity, though mastering them required deep experience, meticulous observation of sea conditions, and the ability to quickly adapt to unforeseen changes. Similarly, through decades of exploration along the coast of Africa, Portuguese sailors gradually gathered invaluable knowledge about ocean currents, such as the Benguela current, which aided their navigation southward (for more information on the Benguela current, see Shannon [30]). However, the unexpected remained a constant threat to maritime exploration, particularly in the form of storms that could severely damage ships or push them off course, while reefs and sandbanks—often poorly mapped—presented a constant danger.

In addition to the logistical challenges of optimizing routes in high-risk environments, sailing also involves complex human resource management, much like any supply chain. Illnesses, particularly those caused by vitamin C deficiency due to a lack of fresh fruits and vegetables on board, could devastate crews, leading to symptoms ranging from extreme fatigue to fatal hemorrhages. For example, during Vasco da Gama's first voyage to India, half the crew perished from diseases, including scurvy [4]. Discipline on board was another significant challenge, as promiscuity, poor living conditions, and the uncertainty of the voyage often fueled conflicts between crew members. Captains had to enforce strict rules to maintain order, risking mutiny, as famously depicted in the Hollywood film about the Bounty rebels [2]. Christopher Columbus kept a detailed logbook, recording not only the progress of the voyage but also the behavior of the sailors, severely punishing any form of disobedience to ensure crew cohesion and discipline. This strict oversight was essential for both the survival of the crew and the success of the voyage.

Despite numerous obstacles, the explorers demonstrated a remarkable ability to adapt to unpredictable circumstances. Damage occurring at sea was repaired on board using materials brought along before departure, and the ship's carpenters, present on every vessel, played a crucial role. They skillfully used wood, tar, and rope to seal breaches or replace defective parts [18]. When the damage was too great to fix on board, explorers sought refuge in coves or bays, where they carried out more substantial repairs or even partially rebuilt their ships. Maritime itineraries were then adjusted according to the conditions encountered, ensuring continued progress. Portuguese sailors developed a strategy of establishing logistical bases along the African coast, such as those at São Jorge da Mina (now Ghana) or Mozambique. These bases served not only as critical procurement points for food and fresh water but also as hubs for exchanging valuable information on ocean currents, coastal hazards, and local trade routes. This network of bases significantly enriched their logistical understanding of the vast territories being explored, improving navigation and increasing exploration success.

The use of logistical bases reflects a *strategy of progressive navigation*, where each stop significantly enhances the chances of success for the next phase of exploration. This method is especially evident in Vasco da Gama's voyages, whose route to India relied on a series of carefully chosen strategic stops at these bases (see Figure 2). These stops were not only used to resupply crews but also to negotiate with local populations for additional resources, establish trade agreements, or forge effective commercial alliances [24]. This approach contrasts sharply with that of Christopher Columbus, who ventured directly into the open ocean without any prior logistical support, relying instead on his mystical faith and belief that the venture would ultimately succeed. Clearly, the strategy of progressive navigation was pivotal to the success of Portuguese explorers, particularly as their voyage accounts became invaluable resources for preparing future expeditions. In short, each voyage and every logistical base used contributed to a growing and invaluable body of knowledge, vital for tackling subsequent explorations more efficiently, with better foresight, and with greater preparation.

LEGACY

The logistical legacy of 15th-century maritime explorations is significant, as explorers played a key role in refining maritime transport techniques, particularly through the enhancement of nautical charts and the adoption of more accurate instruments like the quadrant and astrolabe. These tools were gradually integrated into logistical practices, enabling a better understanding of ocean currents, improving navigation, and increasing the precision of ship positioning at sea. The growing mastery of maritime routes not only shortened the distances between continents but also facilitated global trade, fostering a new level of planetary interconnection and sparking the emergence of new economic dynamics. The new trade routes opened by Vasco da Gama to India and by Magellan to the Philippines had a profound and lasting impact on the exchange of goods, wealth, and culture between Europe, Asia, and the Americas. Spices, silks, and precious metals began circulating in intercontinental networks, disrupting local economies, shifting global power balances, and accelerating the development of merchant capitalism in Europe, as Braudel [3] insightfully emphasizes.

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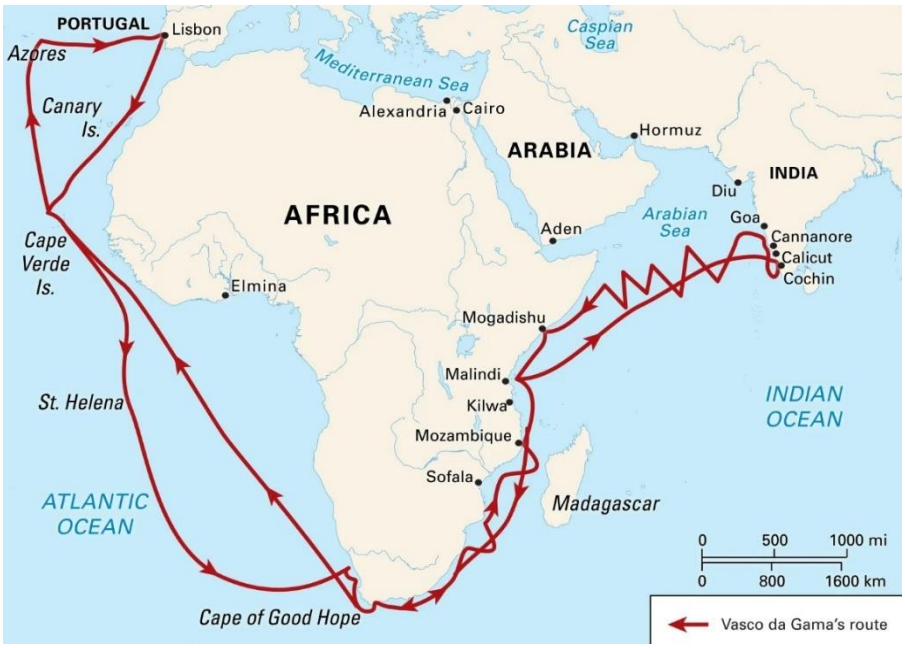

Figure 2: Vasco de Gama's first voyage to India (1497–1499)
Source: By courtesy of © Encyclopædia Britannica, Inc., 2015; used with permission.

However, the logistical advances of the 15th century were not without significant negative consequences. The maritime explorations of this period marked the beginning of widespread colonization, with profound and enduring impacts. The newly discovered territories were subjected to domination, plunder, and the systematic exploitation of natural resources, while indigenous populations, faced with foreign invaders, were decimated by diseases like smallpox, previously unknown to them, or enslaved, fueling the rise of transatlantic trade. Global ecosystems were also drastically altered, as the great maritime explorations initiated a period of intense biological exchanges, known as the "*Columbian Exchange*," involving the transfer of plants, animals, and microbes between continents [21]. While the Columbian Exchange stimulated agricultural development and diversified diets, it also caused significant ecological disruptions. The introduction of invasive species accelerated deforestation, and the intensification of export crops like sugar cane and tobacco led to disastrous environmental consequences in many colonies, further exacerbating social inequalities.

Beyond their ecological and human implications, the maritime explorations of the 15th century clearly marked a major transformation in the logistical understanding of the world. Nautical charts evolved into more accurate representations of known territories, while the concept of the "*New World*" redefined geographical and cultural perceptions. These discoveries fueled a sense of scientific curiosity in Europe, laying the foundations for future explorations and the development of disciplines such as geography, anthropology, and even botany. They also spurred the emergence of new technical knowledge, such as more effective methods for calculating latitudes and improving ships, which had a lasting impact on logistical practices [29]. The maritime explorations of the 15th century were not merely expeditions to uncharted lands or missions to convert indigenous populations. They redefined not only the connections between continents but also the relationships between societies and their natural environments. While they led to remarkable innovations and significant advances, they also

marked the beginning of global dynamics whose lasting repercussions, both positive and negative, continue to shape our present world.

LESSONS

The success of 15th-century maritime explorations relied heavily on meticulous preparation and rigorous resource management. Even before setting sail, these ambitious large-scale projects demanded exemplary organization, mobilizing a wide range of artisanal skills and technical innovations tailored to the unique challenges of ocean crossings. Vessel construction, outfitting, and provisioning required methodical planning, aimed at anticipating risks associated with unpredictable conditions such as storms, equipment failures, or extended periods without refueling. Every detail mattered: from selecting the right materials for hulls to acquiring knowledge of optimal shipping routes, everything had to be carefully considered to ensure the expeditions' viability. The strategic focus on preparation and risk management resonates strongly with current's large-scale endeavors, whether building a power plant or establishing a global supply chain. In both cases, success depends on anticipating unforeseen obstacles, optimizing limited resources, and coordinating diverse human expertise. The enduring relevance of these principles shows that the lessons from 15th-century maritime explorations remain vital for modern project management in a world of continuous challenges and evolving demands.

Vital Role of Thorough Preparation

15th-century shipbuilding, exemplified by the famous caravels, highlights the critical role meticulous preparation played in the success of maritime expeditions. Ships were purpose-built to tackle the challenges of ocean crossings, including long distances, unpredictable weather conditions, and storage limitations. Their construction required exceptional coordination of material resources—wood for the hull, iron for fastenings, ropes for rigging—alongside the expertise of specialized craftsmen such as carpenters, sailmakers, and blacksmiths. Equally vital were the contributions of sailors, whose practical knowledge of winds and ocean currents significantly influenced the success of these voyages. This close collaboration between diverse fields of expertise demonstrates that effective expedition logistics relied not only on technical innovations, but also on an *interdisciplinary* and *collective approach*. Such an organizational model, marked by the optimization of resources and synergy between skills, offers enduring lessons in project management, particularly in how it emphasizes adaptability, teamwork, and problem-solving to navigate unforeseen challenges and achieve ambitious objectives.

In the energy sector, building a renewable power plant presents a challenge comparable to that of 15th-century maritime explorations [15]. From the design phase to sourcing materials and training teams, every aspect of the project must be meticulously planned to avoid potential setbacks and ensure smooth execution. Proactive risk management, particularly in response to unforeseen events such as geopolitical crises, natural disasters, or market volatility, remains central to modern supply chain strategies [10], just as it was for 15th-century navigators who had to prepare for storms, food shortages, and uncharted routes. The thorough preparation seen in maritime explorations—where every detail, from sail design to provisioning, was anticipated—parallels the execution of large-scale contemporary projects. In both cases, success hinges on the capacity to foresee challenges, optimize resources, and orchestrate

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diverse stakeholders in an ever-changing global landscape, where technological advancements, environmental considerations, and regulatory constraints add additional layers of complexity to decision-making.

Resource Management in Extreme Conditions

15th-century navigators, confronted with the daunting challenges of long ocean voyages, demonstrated remarkable ingenuity in managing the limited resources available onboard. Food was strictly rationed to ensure its availability throughout the entire journey, while fresh water—a precious and often scarce commodity—was stored in barrels. These constraints, driven by the unpredictable duration of the crossing, fluctuating climatic conditions, and the uncertainty of maritime routes, forced crews to carefully monitor and optimize their supplies. As previously noted, scurvy, a debilitating disease caused by vitamin C deficiency, frequently devastated crews, prompting explorers to seek innovative solutions to this nutritional gap, often through empirical experimentation. Techniques such as rainwater harvesting and establishing logistical bases were critical for extending the duration of expeditions. This meticulous management of resources, though restrictive, highlights the resilience and resourcefulness of human beings when faced with extreme logistical challenges, underscoring the determination to succeed under harsh conditions.

Managing modern supply chains as effectively as possible presents challenges like those faced by 15th-century explorers, although current issues are framed within a much broader global geopolitical context [23]. Multinational companies are confronted with disruptions, including economic crises, environmental disasters, and military tensions. The COVID-19 pandemic underscored the vulnerability of global supply chains and highlighted the critical importance of resilience in addressing the pandemic's consequences, particularly about procurement shortages [19]. Just as 15th-century explorers were compelled to implement improvised solutions at sea, today's businesses must develop innovative strategies to navigate the disruptions they encounter. The key lessons learned from maritime exploration, where meticulous planning, flexibility, and adaptability were crucial, are directly applicable to modern supply chain management. Indeed, optimizing inventories and implementing robust contingency plans are now essential to ensure business continuity in an increasingly fragile world, especially following the outbreak of the conflict between Ukraine and Russia. As we move forward, embracing technology and fostering collaboration will be vital in overcoming these challenges and ensuring sustainable growth.

Adaptability to the Unexpected

Adaptability was a crucial quality for 15th-century explorers, who faced the constant dangers of perilous ocean crossings. Violent storms, unforeseen damage, navigational errors, and disease could wipe out entire crews at sea. Isolated from help, sailors had no choice but to repair their ships on the high seas, adjust their routes to unpredictable winds and currents, or devise innovative solutions to health and logistical challenges. Complexity was the norm, and every unexpected event tested their resilience and ingenuity. Over time, this environment of extreme uncertainty nurtured a pragmatic and flexible approach to logistics, where the ability to innovate quickly became essential to the crew's survival and the economic success of their expeditions. Driven by constant observation and empirical learning, this adaptability not only solved immediate problems but also improved practices for future voyages. These invaluable

lessons in resilience, coordination, and organization remain highly relevant, as the modern business world faces similar challenges, where innovation and flexibility have become strategic imperatives for success and long-term sustainability.

Adaptability is a crucial strategic skill, especially in a context marked by rapid and unpredictable change. The digital age has transformed markets into dynamic ecosystems, requiring organizations to respond quickly to emerging consumer trends and expectations. This is exemplified by Amazon's adoption of a same-day delivery model to meet the growing demand for immediacy [1]. During the global semiconductor shortage triggered by the COVID-19 pandemic, major technology companies were forced to rethink their global supply chains. They diversified procurement sources, forged new supplier partnerships, and optimized inventory management to maintain production continuity [22]. This ability to swiftly adapt, supported by advanced technological tools and real-time data analysis, has become essential in a hyper-competitive environment. In such a landscape, disruptions can lead to significant sales losses to competitors or substitute products, emphasizing the importance of proactive and resilient strategies. Ultimately, organizations that prioritize adaptability are better positioned to thrive in uncertainty and seize new opportunities as they arise.

Knowledge Acquisition and Transfer

15th-century maritime explorations provide an excellent example of how leveraging experience can drive future performance improvements. Each expedition, whether successful or fraught with difficulties, contributed to an expanding body of navigational knowledge. Explorers returned with more accurate maps, detailed observations of ocean currents, refined navigation techniques, and innovative solutions to unforeseen challenges, such as managing food supplies or making repairs at sea. This knowledge, carefully documented, was shared with subsequent expeditions, fostering a continuous cycle of learning, adaptation, and innovation. The collaborative process not only made expeditions more efficient but also better equipped crews for hostile environments. Logbooks, travelogues, and updated maps all played key roles in transmitting this knowledge, symbolizing a culture of collective learning and growth. This spirit of gradual improvement, where each discovery increased the likelihood of success for future expeditions, was essential for expanding the boundaries of the known world and overcoming the immense challenges of exploring previously uncharted territories. It also laid the foundation for subsequent generations of explorers who benefited from these accumulated insights, ensuring the progression of global exploration for centuries to come.

Collective learning remains a cornerstone of contemporary management methodologies. Approaches such as lean management or agile retrospectives are directly inspired by this concept: analyzing past experiences to optimize processes, improve decision-making, and anticipate future challenges. These methods encourage the continuous questioning of working practices and results, with the aim of achieving ongoing improvement. In the automotive industry, for instance, companies meticulously analyze data on production defects to identify recurring problems and implement solutions to enhance the quality of subsequent models. Digitization strengthens these dynamics by enabling real-time access to shared data, such as through blockchain technology [27], allowing companies within the same supply chain to draw on collaborative knowledge bases and communication platforms to rapidly disseminate lessons learned across their teams. Collective learning practices not only foster efficiency but also

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encourage innovation and the implementation of rapid, effective solutions to challenges, as highlighted in the supply chain management literature [20]. This is undoubtedly reminiscent of the communities of navigators who shared portolan charts, navigational techniques, and observations to manage increasingly secure maritime explorations over the decades, ultimately transforming logistical practices.

Ethical and Environmental Considerations

Finally, the 15th-century maritime explorations established new trade routes and significantly expanded scientific knowledge but also marked a profound turning point in colonization. While these explorations broadened geographical horizons and promoted cultural exchange, they also led to the exploitation of indigenous populations and the destruction of local ecosystems. In their quest for wealth and power, explorers often disregarded the ethical consequences of their actions, leading to irreparable human and environmental damage. Colonization resulted in the deportation, enslavement, and extermination of indigenous peoples, while drastically altering landscapes and disrupting ecological balances. The history of maritime explorations serves as a powerful reminder of the importance of reflecting on the long-term impacts of human actions. In pursuing progress and development goals, it is essential to integrate ethical and sustainable practices, ensuring that economic and technological advancement does not come at the expense of future generations or the environment. This reflection is key to avoiding the mistakes of the past and preserving the balance between human development and environmental stewardship.

This awareness is even more crucial today, particularly in the context of the ongoing energy transition and large-scale projects such as the development of new energy infrastructures and space exploration. Projects like solar farms or hydroelectric dams often spark debates about their environmental and social consequences, emphasizing the need to assess not only their economic viability but also their long-term impact on future generations. Similarly, in space exploration, missions aimed at exploiting the resources of the Moon or Mars raise critical questions about the responsible management of natural resources [8], in addition to the significant costs involved. The logistical challenges faced during 15th-century maritime explorations, often resolved through innovative solutions, serve as a reminder that success should never come at the expense of human and environmental values. In the present interconnected and globalized world, it is more urgent than ever to integrate *sustainability*, *equity*, and *environmental preservation* into every large-scale project. This approach ensures that technological progress advances in a way that respects both people and the planet.

CONCLUSION

The maritime explorations of the 15th century, undertaken by famous figures such as Christopher Columbus and Vasco da Gama, marked a pivotal turning point in human history. These expeditions not only established new trade routes but also offered timeless lessons in project management, adaptability, and responsibility. While the contexts have dramatically changed since these explorations, the challenges they raised still resonate powerfully in the modern world. The ability to anticipate, meticulously plan, manage limited resources, and adapt to the unexpected remains crucial in large-scale and high-stakes projects. However, the study of maritime explorations is not merely about replicating ancient strategies. It also allows us to reflect critically on the ethics of ambitious projects and their profound impacts on both

the environment and society. In conclusion, it is essential to reassess these historical lessons considering contemporary challenges to extract valuable contributions, recognize their limitations, and establish new perspectives that will guide the future management of large-scale projects effectively.

Contributions

One of the key contributions of 15th-century maritime explorations lies in their approach to planning and resource management under extreme conditions. Meticulous preparation, strategic management of scarce resources, and adaptability in the face of the unforeseen are invaluable lessons that remain highly relevant in our modern business world. Navigators' ability to anticipate each step, coordinate multiple trades, and lead teams in uncertain, volatile, and turbulent environments continues to resonate, especially in complex projects such as infrastructure development, environmental management, and space mission planning. These maritime explorations also emphasize that the success of any large-scale project depends not only on mastering logistical operations but also on fostering human collaboration, effective communication, and collective learning—three essential components of modern project management. Additionally, the innovative spirit displayed in overcoming challenges such as food shortages or diseases at sea serves as a model of adaptability, one that can still guide the management of contemporary health crises, global trade disruptions, and urgent humanitarian responses. The ability to quickly adapt to unforeseen circumstances and implement creative solutions is a skill that remains indispensable in our rapidly changing world.

Limitations

Applying the lessons of the past to the modern world, however, presents several limitations. While the 15th-century maritime explorations expanded humanity's horizons, they also contributed to colonial practices and exploitative acts with dramatic repercussions for indigenous populations and ecosystems. The lack of ethical reflection, often masked as "*divine will*," and the profound human and environmental impacts of these explorations raise critical questions about how modern corporations should approach large-scale projects. It would undoubtedly be a tragedy to replicate outdated practices—with only minor adaptations—without considering the complex socio-environmental contexts of today. Furthermore, while optimal resource management techniques remain essential, they cannot guarantee success in the face of increasingly intricate global crises, such as climate change, pandemics, and resource scarcity. The management of large-scale projects must go beyond logistical efficiency; it must also integrate social, environmental, and ethical considerations, ensuring a long-term positive impact in project execution. Embracing these broader dimensions is essential for achieving responsible, innovative, and impactful outcomes.

Research Avenues

Three promising research avenues can be explored around an academic program that focuses on the key insights from the 15th-century maritime explorations and their application to the business world of the 21st century. The first avenue could explore how collaborative governance models, inspired by continuous exchanges between navigators, can be adapted to contemporary large-scale project management. This would involve examining the integration of stakeholders and local communities to ensure projects address the diverse needs of society. A second research avenue would investigate the impact of digital technologies on project

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management. It would focus on how the use of digital platforms for knowledge sharing and resource management enhances efficiency, transparency, and fosters collective innovation in the present business environment. Lastly, a third research avenue would examine ethical practices in large-scale projects, offering an in-depth analysis of how historical mistakes are guiding companies and governments toward development models that respect social and environmental justice principles, while addressing the contemporary challenges of economic performance. By exploring these topics, the research could bridge historical knowledge with modern strategies for sustainable success.

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