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Temporal Development Patterns of Inner Solar System Colonization in Comparativist Perspective

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Abstract

This qualitative study asked research questions on Moon and Mars colonization, as these celestial bodies in the inner solar system attract human presence. In which timeframes will the colonization of Moon and Mars begin and result in creating habitats as political entities with human populations? Which media content provides educational examples for Moon and Mars colonization, depicting nature and timeframes of the colonization processes realistically? The objectives were to determine timeframes for Moon and Mars colonization and to identify educational media examples for both processes. Literature on political and media-reflected space colonization highlighted the need to identify precise temporal colonization patterns and media content, which informed these timeframes. Within the Historical Cycles theory, philosopher Oswald Spengler's analogy approach was employed as a research method, using political-historical comparisons between the Roman conquests of Gaul and Britain and the Western colonization timeframes of Moon and Mars, projecting past Roman events onto future Western occurences. Outcomes revealed that limited exploratory base creation on the Moon would begin after the human return in 2025. These bases would evolve into specialized exploratory bases around 2045, with human settlements forming as political entities in the 2090s, reaching growth saturation in the 2120s. Exploratory Martian bases would emerge from the 2090s onward, with human settlements forming political systems from the 2160s or 2190s onward, reaching development consolidation in the 2230s. Media content that communicated timeframes of lunar and Martian colonization realistically included the movies Moon (2009), Ad Astra (2019), and the TV show The Expanse (2015–2022).

Introduction

The study background of inner solar system colonization will begin with the anticipated human return to the Moon by 2025 under NASA's Artemis program. However, scholars had divergent views on when creating human population habitats on the Moon and Mars, the most significant celestial bodies, will exactly occur. For instance, SpaceX entrepreneur Elon Musk believed establishing a Mars habitat with a million settlers might be doable by 2050 (Yap & Kim, 2023). In contrast, Doboš (2023) projected such events further into the future, while the UAE government planned for an inhabited Mars settlement by 2117. These distinctions highlighted a research gap, as space colonization will become practical from 2025 onwards, necessitating a precise definition of the temporal development patterns of Moon and Mars colonization, including political-cultural impact factors. Since settling other celestial bodies will result in the creation of extraterrestrial political entities (Doboš, 2022, 2023), this qualitative study employed a political studies approach. Additionally, Oswald Spengler's (1998) theory of Historical Cycles was applied for a political-historical comparison between the ancient Roman colonization of Gaul and Britain during the Classical high culture and comparative processes in the West, to arrive at the most precise projections for the anticipated timeframes of Moon and Mars colonization.

Furthermore, there was a need to identify media-cultural means to support the space colonization process by raising societal awareness about its realistic temporal patterns. Notably, Robert Zubrin (2021), the founder of the Mars Society, called for spreading cultural awareness of this process, especially Mars colonization, to positively influence future political decisions. In the 21st century, the most effective cultural tools for reaching mass audiences were movies and TV shows due to their audiovisual impact. Thus, this study identified audiovisual content that realistically communicated about Moon and Mars colonization and their expected timeframes. As existing literature (Klimchynskaya, 2022; Moss-Wellington, 2020) had not yet identified media content for this exact, above, educational purpose, this study analyzed media works in this context by applying Henry Jenkins' (2009) theory of participatory culture.

Defining the timeframes for Moon and Mars colonization, with precise political-cultural impact factors, by applying political-historical and media-educational perspectives, was necessary for two reasons. Firstly, papers such as Doboš' (2022, 2023) contributions, which applied a political perspective in the study context, were scarce, despite the explained, increased need for such an approach. Secondly, media scholarly papers identifying audiovisual content for educational purposes, due to realistic depictions of temporal space colonization patterns, did not exist. The significance of advancing knowledge in these study contexts arose because solar system colonization formed the most impactful human project of the third millennium. Lastly, the study was significant as it could contribute to a more realistic understanding of how the timeframes of this entire process would unfold and be affected by political-cultural factors, thereby carrying practical planning implications.

This study was based on two research questions and their related objectives.

RQ1: In which timeframes will the colonization of Moon and Mars likely begin and result in the creation of habitats as political entities with human populations?

RO1: To determine likely timeframes for the beginning of Moon and Mars colonization, covering the early development from specialized or temporary to exploratory bases, and the subsequent creation of habitats as political entities with human population, growing until reaching their late saturation points. Emphasis was also placed on specific political and cultural factors impacting the evolution of human habitats.

RQ2: Which media content provides educational examples for Moon and Mars colonization, depicting the nature and timeframes of the colonization processes realistically?

RO2: To determine which media content, limited to fictional or fictionalized movies and TV shows, primarily science fiction, provides educational examples for Moon and Mars colonization, depicting both nature and timeframes of the colonization processes realistically. The focus was on 21st-century content, which was temporally closer to the examined timeframes.

This research paper was organized as follows. The Introduction was succeeded by the chapters Literature Review, Research Methodology, Results, and Discussion. Finally, the paper ended with Conclusion, Implications of the Study, Limitations and Recommendations for Future Research.

Literature Review

Scholars widely agreed that human return to the Moon was imminent. Estimates for establishing a permanent lunar presence ranged from 2028 (Dallas et al., 2021), the 2020s in general (Swan, 2023), the late 2020s and early 2030s (Doboš, 2023), to the 2030s in general (Chavy-Macdonald et al., 2021). Initially, habitat creation would focus on very limited areas of the lunar south polar region, likely the Aitken basin, with permanently illuminated areas for solar energy generation located near permanently shaded areas, probably containing water ice as a resource (Brown et al., 2022; Song et al., 2021). Additionally, geopolitical competition pitted the Artemis project, led by the United States in collaboration with Europeans and Japanese, against the planned Chinese-Russian lunar research station (Song et al., 2021). Over time, lunar settlements were projected to evolve from limited to more specialized exploratory bases, somewhat akin to scientific bases in Antarctica; evolving into colonies with long-term residents, and finally larger entities with citizens. However, these Moon colonies were unlikely to achieve self-sufficiency from Earth (Doboš, 2023). The most comprehensive contribution on lunar settlement was provided by Bohumil Doboš, using a geopolitical perspective, necessitated by the need to understand the above near-future processes.

By comparison, the assessment of human Mars colonization specifics was similarly detailed. Projections ranged from 2029 for establishing a temporary base (Zubrin, 2021), sometime shortly after the 2020s (Swan, 2023), to the creation of a massively populated habitat with a million people by 2050 (Yap & Kim, 2023), or establishing a large-scale civilian settlement by 2117 (Grove, 2022). However, temporary bases were prerequisites for the first human landings on the Red Planet, requiring at least one-year mission stays (Zubrin, 2021). Mars colonization was expected to follow a similar evolution as lunar settlements, progressing from simple bases to cities with larger civilian populations and political systems. A significant distinction was the presence of numerous regions with likely reserves of subsurface water ice and favorable climates, such as in the lowlands of the northern hemisphere near the equator, which could likely prevent geopolitical competition for scarce areas as anticipated for the Moon (Doboš, 2023). Furthermore, due to its distance and the six- to nine-month journeys from Earth compared to three-day trips to the Moon, Mars was likely to become more independent and self-sustainable (Zubrin, 2021). Robert Zubrin's work on Martian colonization was outstanding in terms of depth and quantitative scope, focusing primarily on engineering solutions, while also addressing political-social aspects of human Martian life in the far future.

The literature review of academic studies on Moon and Mars colonization depiction in cinema and TV revealed a diversity of perspectives. Firstly, Holland (2024) analyzed manned TV spaceflight documentations as informing human perception and politics on spaceflight, emphasizing the first manned Moon landing in 1969 as a significant TV event. According to Klimchynskaya (2022), movies like The Martian (2015) and TV shows such as Away (2020) have familiarized humans with future travels to Mars. Moss-Wellington (2020) viewed the Moon mission drama Apollo 13 (1995) and The Martian (2015) as reasonably accurate but criticized their portrayal of scientific innovation as overly individualistic and heroic, thereby reducing complexity and social reality by promoting American values. Wu and Wang (2023) perceived Western science fiction narratives, including those set on the Moon and Mars, as potentially thought-stimulating while reflecting Earthly issues and impacting East Asian TV content, yet potentially avoiding reality and educational aspects of space colonization. Lastly, Mann (2022) critiqued the transformation of the Jordanian desert, used as a shooting location, into an abstract Martian landscape as a form of cultural colonialism, possibly unconscious.

Existing literature on political and media-reflected space colonization aspects necessitated this further research to identify precise timeframes and political-cultural impact factors on colonization, and educational media content informing on these temporal patterns. Literature on lunar colonization highlighted the initial, permanent exploratory base creation but neglected their evolution into civilian and political entities, saturation points, and political-cultural factors (Dallas et al., 2021; Doboš, 2023). Similarly, academic works on Mars colonization mentioned expected timeframes for creating temporary exploratory bases but overlooked permanent establishment timeframes, provided contradictory temporal development patterns for civilian colonies as political study subjects, ignored saturation points, or lacked precision on political-cultural factors (Doboš, 2023; Yap & Kim, 2023; Zubrin, 2021). Media-analytical studies identifying educational content in the study context stressed scientific accuracy (Moss—Wellington, 2020) and familiarization with future events (Klimchynskaya, 2022), but primarily focused on cultural criticism or omitted communication of temporal space exploration patterns. While Holland's (2024) study on manned spaceflight documentation had an educational focus, highlighting TV depictions of real events, fictional content, due to its dramatization potential, would be more beneficial in the study context, except for broadcasting the first manned Mars landing.

Research Methodology

This study used a comparativist, political-historical method to draw analogies addressing the first research question. This method utilized Oswald Spengler's Theory of Historical Cycles, formulated in early 20th-century Germany by the cultural-historical philosopher. Spengler's theory notably enhanced the understanding of Classical and Western high cultures.

Historical Cycles dismissed the notion of a unified global history with ongoing progress, proposing that eight historical high cultures developed independently through 1,000-year cycles, each having four phases. This repeated occurrence enabled projecting an older culture's development onto a younger high culture. Notably, Spengler suggested comparing the extinct Classical high culture of the Greeks and Romans (1100 BC–200 AD) with the living Western high culture (since 900 AD) due to their shared heritage. Although approximations were inherent in Spengler's comparisons, his method's precision offered unmatched predictive verisimilitude for future developments in Western politics. However, analogies had to be necessary and logically coherent. For example, comparing the transition from the

Roman Republic to the Roman Empire (134–27 BC) in the Classical culture to similar Western processes established corresponding and relevant analogies (Spengler, 1998).

The prime symbol distinguished each high culture. The Classical high culture, once surrounding the Mediterranean, centered on the physical body as its prime symbol, foundational to all its cultural expressions. For example, physically realistic statues symbolized its highest art form, while the physical body of the city-state served as the essential political unit. Comparatively, the Western prime symbol was the infinite space, representing a quest to comprehend nature's mysteries and a distinct will-to-power aiming into the infinite distance. Thus, the pinnacle of Western culture was Classical music, resonating acoustically through space. The Western pursuit of infinity was expressed through its sophisticated, distinct technology, serving as a means of ultimate power. Both above prime symbols were essential in this study, explaining why Roman conquest in the Classical world extended over limited geographical territories, while Western expansion aimed at other celestial bodies within the solar system (Spengler, 1998).

In particular, the Roman conquests of Gaul (125–27 BC) and Britain (55 BC–84 AD) in the Classical world were compared to the Western colonization processes of the Moon (from 2025 onwards) and Mars. The conquest of Gaul represented an external Roman power expansion during the internal transition from Republic to Empire (Broughton, 1951, 1952; Drinkwater, 2014), while the conquest of Britain was part of the broader Roman Empire expansion (Alcock, 2011; Matyszak, 2003). Identifying larger political processes that both Roman conquests coincided with, or were constitutive of, mattered methodologically, following Spengler's (1998) theory to predict the timing of corresponding Western colonization processes on the Moon and Mars.

This study applied Henry Jenkins' media-cultural concept of participatory culture to identify cinema and TV content depicting Moon and Mars colonization scientifically accurate and approximately within the timeframes determined in this study to answer the second research question. Jenkins emphasized the potential of popular media, including films and television, to educate audiences through storytelling. Furthermore, this approach could foster a more participatory culture by encouraging engagement with content, critical thinking, and collaborative learning. Movies and TV shows would be effective due to their visual and auditory stimuli, making content more relatable, engaging, and comprehensible, thereby sparking discussion, forming fan community, and inspiring new content creation (Jenkins, 2009). Jenkins' concept of participatory culture aligned with Zubrin's advocacy for spreading cultural-artistic awareness on Mars colonization to positively influence future political decision-making in this context (Zubrin, 2021). Lastly, this above concept also resonated with Spengler's call to educate especially the youth in addressing major, multi-generational societal tasks (Spengler, 2018). Undoubtedly, inner solar system colonization of the Moon and Mars represented such a task.

Results

The results, along with the subsequent discussion, addressed both research questions in two sections, employing Spengler's political -historical analogy approach through secondary data analysis and Jenkins' media-cultural concept. The results confirmed the two research objectives, which were to determine timeframes for Moon and Mars colonization and to propose suitable media content for educating on these processes.

Results on Temporal Development Patterns of Moon and Mars Colonization

The respective, distinct Classical and Western prime symbols of the physical body and infinite space were critical in the study context. The Classical conquest of Gaul by the Romans, requiring the crossing of the Alps as a close geographical-physical body, would correspond in the Western context to the colonization of the Moon, necessitating a short journey of a few days through the close infinite distance of outer space.

The Roman conquest of Gaul occurred in several stages from 125 to 27 BC. This conquest coincided with the transition from the Roman Republic to the Empire, which began with the election of Tiberius Gracchus as Roman plebeian tribune in 134 BC and ended with Emperor Augustus' coronation in 27 BC (Ehret & Sani, 2022). From 125 to 109 BC, the Romans expanded into southern Gaul, defeating Gallic, Celtic, and Germanic tribes, and establishing the province of Gallia Transalpina, bordering the Italian peninsula. Importantly, Cesar's bloody military campaigns from 58 to 50 BC decisively established control over almost all of Gaul, forming the central event of Rome's Gallic conquest. Subsequently, this conquest was successfully consolidated despite local unrest und revolts until 27 BC (Broughton, 1951, 1952; Drinkwater, 2014; Matyszak, 2003).

The corresponding lunar colonization would begin in 2025 with a human return to the Moon within the US-led Artemis program, 56 years after the first manned Moon landing in 1969. Similar to the above Roman processes, the lunar colonization would coincide with the century -long transition from American Republic to Empire, which the United States entered from 2016 onwards, marked by the election of Donald Trump as US president, the American analogy of Tiberius Gracchus (Ehret & Sani, 2022). This Artemis project, including Europeans and Japanese, was projected to achieve a permanent human presence near or on the Moon by 2028 (Dallas et al., 2021), provoking a non-Western response aimed at establishing a Sino-Russian lunar research station in the 2030s. Notably, these first limited exploratory bases by geopolitical rivals would be located in the south polar region, competing for scarce areas allowing permanent access to solar energy and proximity to water ice. Subsequently, similar limited exploratory bases would likely be established in the north polar region, as the second-best choice in terms of energy and resource accessibility (Brown et al., 2022; Doboš, 2023, Song et al., 2021). Importantly, the lunar polar regions, especially the south pole, would in the Western process of Moon colonization (2025–2045) function as initial footholds, comparable to South Gaul in Rome's Gallic conquest (125–109 BC).

The subsequent stages of lunar colonization would likely witness the evolution of human settlements, driven by increasing economic viability. The year 2045 could signify a pivotal moment as Beijing aimed to establish a lunar economic-industrial zone, likely coinciding with Western initiatives. Moreover, this economic zone may lead to the development of specialized exploratory bases in non-polar regions, catering to economic interests such as helium-3 mining in Mare Tranquilitatis to secure energy supplies for nuclear fusion reactors on Earth (Bedard, 2019; Doboš, 2023). In the Western context of lunar colonization, the 2090s could mirror the significance of the 50s BC in Roman Gaul's conquest, expanding human presence and influence across most of the lunar surface. This period should witness the formation of colonies as political entities, accommodating long-term residents. If Moon colonization would be consolidated at a saturation point about a century after its inception, akin to the Roman conquest of Gaul, larger political entities with robust living standards and economic foundations, including tourism opportunities, should exist by the 2120s (Drinkwater, 2014; Ryan & Kutschera, 2007). However, due to its proximity to Earth and reliance

on Terran supply chains, the Moon would unlikely achieve independence but would more likely function as an extension of Earth, akin to an eight continent (Alvarez, 2020).

Extending this above analogy between Gaul and the Moon, the Classical conquest of Britain, requiring the Romans to cross the far maritime-physical body of the English Channel, would serve as most fitting analogy to the Western colonization of Mars. Colonizing Mars would necessitate a journey lasting several months through the far infinite distance of outer space.

The Roman conquest of Britain occurred in distinct stages spanning from 55 BC to 84 AD. This conquest was part of the broader Roman Empire expansion, which began with the Empire formation in 27 BC and reached its zenith during the reign of Emperor Trajan in 117 AD (Jackson, 2022). In 55 and 54 BC, Cesar attempted two military invasions of Britain, which, while not entirely unsuccessful, ultimately led to his withdrawal to the European continent due to political challenges in Gaul and Rome. A lasting Roman conquest of Britain was achieved about a century later, from 43 to 84 AD. Emperor Claudius and Aulus Plautius led the initial conquest from 43 to 47 AD, encompassing the establishment of the Roman province of Britannia in 43. Subsequently, the conquest stage culminated into significant northward territorial advances under the command of Agricola from 77 to 84 AD, consolidating this conquest. Comparatively, the Roman conquest of Britain lasted about four decades longer than the earlier conquest of Gaul (Broughton, 1952; Drinkwater, 2014; Matyszak, 2003).

Applying the temporal development patterns of Roman Empire expansion in Britain to Western space colonization equated Cesar's failed invasion attempts in 55 and 54 BC with establishing a permanent Martian exploratory base in the mid-2090s. However, this analogy would suggest that this Roman withdrawal process corresponded to the Western process of creating a permanent Martian presence. But internal coherence supported this interpretation. If we projected the temporal gap between the first moon landing in 1969 and the anticipated human return to Earth's natural satellite in 2025 onto the establishment of a permanent human presence on Mars as suggested above, this event would occur between five and six decades after the first manned Mars landing, likely dating the latter in the late 2030s. This expectation would roughly align, within a margin of up to a decade, with Zubrin's (2021) estimate of a crewed Mars mission's timeframe. Additionally, the existence of exploratory bases only by the 21st century's end would confirm Doboš' (2023) belief that Martian settlements will not be subject to near future geopolitical considerations.

The successful Roman conquest of Britain from 43 to 84 AD could predetermine the transformation timeframe of Martian colonies as political entities, transitioning from initially sheltering long-term civilian residents to accommodating colonial citizens. Accordingly, this Martian evolution might occur between the early 2190s and the mid-2230s as its temporal saturation point. However, this analogy would suggest a long gap between permanent exploratory base creation and establishing a political, civilian habitat. It was important to note that Spengler's (1998) analogies, although measured in the unalterable units of human generations, provided only approximations. While a deviation of a few decades within broader processes when comparing the above Classical and Western timeframes was possible, deviations would not span centuries. Projecting the anticipated time gap between establishing a permanent lunar exploratory base and civilian settlement creation onto comparative Martian projects could indicate the early 2160s as the approximate time for the arrival of Martian settlers who would develop communities with over a hundred people and eventually evolve into societies with over a thousand people, based on a political system (Schmidt & Boháček, 2021). Consequently,

Musk's dream of reaching 1 million Martian inhabitants by 2050, along with the UAE government's projection of establishing a political entity by 2117, appeared overly optimistic (Grove, 2022; Yap & Kim, 2023).

Differently from the Moon, Mars' greater abundance of resources, settlement areas, and distance from Earth would not only foster self-sufficiency but also likely lead to political independence. Doboš' (2023) proposed that an astro-political competition might arise between the Earth-lunar system and the Martian system, including two moons, alongside the geopolitical competition among Terran powers. Doboš' projected Martian sovereignty as a political prerequisite in the distant future, prompting speculation on when this might be achieved.

Taking a speculative, non-Spenglerian approach, the timeframes between the first permanent human presence on Mars and eventual planetary independence from Earth could be estimated by comparing the temporal development patterns of English or British settlements in North America and Australia and their respective paths to independence from the United Kingdom. For instance, it took 113 years from the first British colony creation in Australia in 1788 to achieving a considerable degree of independence in 1901 (Gare & Ritter, 2008). In contrast, the time gap between establishing England's first permanent North American colony in 1607 and the full independence of the United States in 1776 spanned 169 years (Taylor, 2013).

If these trajectories were indicative of Martian sovereignty, accounting for the potential emergence of political unit-forming Martian settlements starting from either the 2160s or 2190s, then Martian independence could feasibly occur between the early 2270s and early 2360s.

Martian independence could be aided by partial terraforming, improving living conditions on the Red Planet. Zubrin (2021) proposed releasing frozen carbon dioxide (CO_2) gas into the Martian atmosphere using methods like orbiting mirrors reflecting sunlight onto the Mars regolith surface and greenhouse gas emissions. His calculations suggested releasing enough CO_2 within about seven decades to raise Mars' current atmospheric pressure (6–10 millibars) to 170 millibars, enhancing radiation protection. This revolutionary approach would increase Martian temperatures by 30 to 35 degrees Celsius, reaching a new average of -25 to -20°C. Depending on seasons and regions, these above temperature and pressure levels would allow liquid water on the surface and likely support the introduction of primitive plants such as ryegrass and lichen. Importantly, humans could walk outside wearing only warm clothes, a breathing mask, and an oxygen tank for humid air, eliminating the need for pressure suits. If partial terraforming began alongside civilian settlement in the 2160s or 2190s, achieving this outcome by the 2230s or 2260s would not only increase the accessibility and value of Martian land but also fuel aspirations for independence.

Spengler dated the end of Roman Emperor Aurelian's reign in 275 AD as the demise of the Classical high culture, thus predicting the end of the West's historical cycle to occur in the first decades of the 25th century. While some high cultures survived the end of their cycles in a millennia-lasting petrified state, the West, due to its transformatory will-to-power, was too volatile and unstable, too scientifically and technically extreme in its achievements, to share a similar fate. This end of the West would cause the unique Western technology, which enabled Moon and Mars colonization, to disappear (Spengler, 1998). Consequently, human space colonization could forever come to an end shortly after 2400.

Results on Media Content Educating on the Temporal Development Patterns of Moon and Mars Colonization

This section employed Henry Jenkins' media-cultural concept of participatory culture to identify rather realistic fictional movies and TV shows on

Moon and Mars colonization that aligned with the aforementioned temporal development patterns. These media could serve the educational purpose of raising cultural awareness about this above process. First, media content on Moon colonization was analyzed, followed by similar content on Mars colonization. Lastly, media addressing the colonization of both celestial bodies was analyzed against the defined requirements.

Two fictional movies were analyzed, which realistically depicted human activities on the Moon within realistic timeframes. The first work, First Man (2018), portrayed Neil Armstrong, the first human to step on the Moon in 1969. Apart from the accurate timeframe, as it depicted a historical event, the film's detailed attention to space travel mechanics and astronaut experiences provided a realistic context for understanding future lunar missions. Although this biographical drama was set in the past and thus did not communicate future temporal development patterns, it entirely met Spengler's recommendation to educate the youth about challenging tasks by learning from the biographies of successful achievers (Spengler, 2018). Additionally, the second work that could, in Jenkins' (2009) sense, support a participatory culture advocating Moon colonization was Moon (2009), set in 2035. While the story addressed ethical malpractices of Moon exploration, the film also depicted lunar mining and the psychological isolation effects of long-term space habitation in a scientifically grounded way, which could support the desired educational effect. The existence of a specialized exploratory lunar base, in Doboš' sense (2023), in the film predated the above timeframe expectations by only roughly a decade, what was still acceptable.

Two media content formats were selected to align with Jenkin's media-cultural concept of engaging audiences in the context of Mars colonization. Both the movie The Martian (2015) and the docudrama Mars (2016–2018) qualified in this analytical context due to including fictional storylines, providing scientifically rather accurate speculations about human missions to Mars and potential solutions for Martian environmental challenges. The Martian depicted the creation of Mark Watney's temporary exploratory base "The Hab" by 2035, and the TV show portrayed the first manned Mars landing by 2033, both timeframes close enough to meet the above suggested projections. However, the docudrama set the beginning of Mars colonization through permanent exploratory base creation about six decades earlier than anticipated. Comparatively, The Martian emerged as the more commendable work in this study context, despite not featuring a permanent human settlement on Mars and exaggerating the impact of Martian sandstorms for narrative purposes.

Additionally, a potential future adaptation of Kim Stanley Robinson's acclaimed book trilogy on Martian colonization could have the most desirable impact in terms of Jenkin's participatory culture. If Robinson's science fiction works, Red Mars, Green Mars, and Blue Mars, were adapted for TV, they could deeply root a mainstream audience in understanding the Martian settlement and terraforming process (Robinson, 2015). However, the content and timeframes of this fiction trilogy would not align with the outcomes of this study. Firstly, no permanent Mars base with a hundred colonists would be established by 2026; but permanent bases would likely only emerge from the 2090s onward. Secondly, complete terraforming of Mars to create a breathable atmosphere, unlike the partial terraforming process described earlier, would probably never happen.

Three media works depicting Moon and Mars colonization were analyzed to assess their effectiveness in engaging a 21st-century audience in participatory ways, aligning with Jenkins' intentions.

For All Mankind (2019–present), an alternate history series, depicted the creation of lunar and Martian exploratory bases with a realistic approach to technological advancements and space travel logistics. However, the purposefully advanced timeframes established the first permanent Moon base ("Jamestown") in 1973 and the first permanent Mars base ("Happy Valley") in 1994. These dates would significantly predate projections based on the above temporal development patterns, by roughly half a century for the Moon base and a full century for the Mars base.

Comparatively, Ad Astra (2019) portrayed missions to the Moon and Mars based on current scientific understanding. The film depicted a heavily commercialized lunar settlement in the early 22nd century, designed to accommodate civilians and tourists. However, certain lunar zones experienced military and geopolitical conflicts. In contrast, the Martian base seemed predominantly focused on scientific research and exploration. Notably, both celestial body settlements aligned roughly with the earlier proposed temporal development patterns, suggesting a long-term, civilian lunar colony as a political entity with long-term residents and a permanent Martian exploratory base existing from the 2090s onward.

Lastly, the TV show The Expanse (2015–2022) was most useful in this study context for communicating realistic expectations about the nature and timeframes of advanced lunar and Martian colonization. Set approximately in the 2350s, both the Moon and Mars featured highly advanced civilian settlements, aligning with the study's suggestions that such settlements would emerge on the Moon from the 2090s onward and on Mars from the 2160s or 2190s onward. While the Moon remained politically under Earth's control, Mars had evolved into an independent planet, rivaling Earth in an astro-political competition for solar system dominance. As depicted in the TV show, Martian sovereignty by the mid-24th century seemed likely. Additionally, the show portrayed Martian settlements underground in the Valles Marineris to achieve radiation protection, based on scientific designs for Martian habitat creation. Surprisingly, the effects of the partial terraforming process depicted in the show at this advanced point in time were even more pessimistic than projected by this study and Zubrin (2021).

Summary of Results

Both research objectives-identifying timeframes for Moon and Mars colonization and determining useful media content for informing about these processes—were accomplished and supported by the results as follows. The outcomes indicated that the establishment of limited exploratory bases on the Moon would likely commence following the human return in 2025. These bases would gradually transform into specialized exploration hubs by around 2045, with human settlements developing into political entities in the 2090s and reaching their growth limits by the 2120s. Martian exploratory bases would begin to take shape from the 2090s onward, with human settlements forming political structures after the 2160s or 2190s, and reaching a phase of development consolidation in the 2230s. Media that accurately portrayed the timelines for lunar and Martian colonization included the films Moon (2009), Ad Astra (2019), and the television series The Expanse (2015–2022).

Discussion

This chapter investigated legal-social and political-cultural factors affecting the temporal development patterns of Moon and Mars colonization in the form of a discussion. Eventually, the discussion verified that both research objectives had been sufficiently fulfilled and that the timeframes for inner solar system colonization were accurate enough.

Discussion of Legal and Social Factors Impacting the Temporal Development Patterns of Moon and Mars Colonization

This discussion assessed the accuracy of the proposed Moon and Mars colonization timeframes and explored whether additional legal-social factors might pose obstacles to or delay colonization, thus requiring a revision of these timeframes. Legal factors included the Moon Treaty, an international agreement adopted by the United Nations (UN) in 1979. Additionally, the national policies of the three key state actors in Moon and Mars colonization were reviewed, including the Artemis Accords established by the United States in 2020 and the bilateral Memorandum of Understanding (MoU) Regarding Cooperation for the Construction of the International Lunar Reseach Station, signed by China and Russia in 2021. Finally, social factors, including global environmentalist movements that may oppose inner solar system colonization, were also analyzed.

The Moon Treaty, officially the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, will likely not impede Moon or Mars colonization. While the treaty prohibited states from claiming lunar or Martian territory and advocated international collaboration, the UN, as the supra-national organization that adopted it, had de facto no enforcement power. Moreover, the U.S., Russia, and China never ratified this treaty, and are therefore not obliged to follow its regulations. In fact, only 17 nations had signed the Moon Treaty (Koch, 2018; O'Brien, 2020).

In contrast, the American-led Artemis Accords, Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes, and the Chinese-Russian MoU were significant. Firstly, their signatory states had enforcement power. Secondly, their legal provisions strongly supported the suggested timeframes for Moon and Mars colonization. Moreover, both legal documents aimed at creating economic activities on the Moon. The MoU from March 2021 aimed at establishing a space economic zone by 2045, while the Artemis Accords, signed by 48 countries in 2020, allowed claiming extracted resources and creating safety zones surrounding operation centers, such as lunar bases, to protect from harmful interference. While sovereignty was not de jure claimed, it would de facto be established in the settlement areas and the zones of economic activity (Doboš, 2023; Nelson, 2020; "Signatories of the U.S.-Led Artemis Accords," 2023). Such a development would follow the logic of U.S. historical experience in how the West of the North American continent was won. Also, it would likely create a precedent for later Mars colonization. If a Martian settlement were to hypothetically declare independence from Earth, it could consider all Terran contracts void and claim Martian sovereignty, perhaps even over the entire Red Planet.

Even the suggested media examples for education on inner solar system colonization depicted these developments seemingly realistically. The film Moon (2009) and the TV series Mars (2016–2018) depicted economic activities on both title-giving celestial bodies. Additionally, the movie Ad Astra (2019) and the TV show For All Mankind (2019–present) even depicted military or armed lunar conflicts between different political actors due to conflicting sovereignty claims, such as between U.S. and Russian bases in the south polar region.

Global environmentalist movements would be unlikely to impede plans for Moon colonization and human landings on Mars in the late 2020s. The second Trump administration (2025-2029) will likely dismiss concerns over environmental and ethical issues related to human space colonization. Moreover, in November 2024, Trump appointed billionaire space enthusiast Elon Musk to co-lead the U.S. Department of Government Efficiency (DOGE), with the goal of removing bureaucratic hurdles for human Moon and Mars missions, including environmental restrictions

(Martichoux, 2024). This was unsurprising, as Musk's company, SpaceX, would be part of these efforts. SpaceX's Spaceship HLS will serve as lunar lander for the uncrewed Moon mission in 2025 and the crewed landings in 2026 and 2028 (Foust, 2023; Smith, 2024). Musk's vision was to send humans to Mars by 2028, though this timeline was unrealistic. His lifelong obsession included establishing a long-term Mars colony using his companies SpaceX to send human colonists with reusable interplanetary transporters, Starlink for satellite communication, and his Boring Company for drilling underground settlements (Ehret, 2022). Also, both the Chinese and Russian governments will prioritize long-term technological, economic, and geopolitical, national goals over environmental concerns, and, while they may involve military aspects, they will neglect private sector efforts (Doboš, 2023).

Discussion of Political and Cultural Factors Impacting the Temporal Development Patterns of Moon and Mars Colonization

The discussion also aimed to gain an enhanced understanding of political-cultural impact factors influencing Moon and Mars colonization. Determining these factors was crucial as Western-dominated lunar and Martian territories could be politically and culturally incorporated into the Western, particularly American, culture resembling the Roman assimilation of conquered Gaul and Britain into the Classical culture (Alcock, 2011; Drinkwater, 2014). Woodard (2011) identified eleven distinct American nations, or regional cultures, formed over centuries almost entirely by European immigration into North America. He perceived Yankeedom, in the greater New England region, and the Deep South, marked by its historical racial hierarchy, as dominant rivals. This discussion explored which of these eleven political-regional cultures could impact the emergence of Western political entities on the Moon and Mars.

The political-cultural characteristics of Western lunar settlements could be strongly impacted by the Appalachian and Far Western regional cultures of the United States. Appalachians, descended from Scots-Irish settlers in states like Kentucky, Tennessee, West Virginia, Arkansas, and Oklahoma, emphasized individuality and military values. In contrast, conservative Far Westerners in states such as Montana, Wyoming, Nevada, Nebraska, and Colorado, perceived themselves as foreign-controlled by East coast corporations due to their mining resources (Woodard, 2011). Mining operations likely to begin on the Moon around 2045, enabled by specialized exploratory base creation (Doboš, 2023), would probably require recruiting military-trained personnel with individualist values, particularly Appalachians. Additionally, the power relations between the United States and the Western lunar settlements, which are likely to be politically and supply-dependent but resource-rich, could mirror the historical dependency of the Far West on the US East coast. Consequently, the political-cultural identity of Western lunar colonies may draw heavily from the Appalachian and Far Western regional cultures. Woodard (2011) noted that a cultural nucleus of a newly emerging political colonial entity could be formed by few hundred initial settlers, with subsequent generations adapting its identity for centuries and in the millions.

Western Martian settlements, likely self-sufficient and destined for political independence, could be strongly affected by political-cultural elements of Yankeedom and the US Left Coast. Yankees, located in states such as Massachusetts, New Hampshire, and Michigan, were known for their social engineering initiatives aimed at transforming the world according to their image. Similarly, the Left Coast, stretched along the coasts of California, Oregon and Washington, shared Yankee messianism and Appalachian individuality, having evolved as an offshoot of both cultures (Woodard, 2011). The ideological

inclination of Yankees and Left Coasters towards societal engineering would resonate well with the Martian terraforming concept, envisioned as the most ambitious engineering project in history aimed at redesigning the material basis of all future planetary political entities. Zubrin's (2021) advocacy for transplanting general American cultural values to Mars as a new frontier supported the above speculation about the political-cultural characteristics of Western Martian settlements. However, he left the specific American regional cultures poised to exert the greatest political-cultural impact unspecified.

No fictional movies or TV shows were identified that explore the political-cultural impact of these above American regional-political cultures on Moon and Mars colonization.

Conclusion

This paper achieved both its research objectives by identifying the temporal development patterns of Moon and Mars colonization and the media content that communicates them. Firstly, limited exploratory base creation on the Moon will likely begin after the 2025 human return, followed by specialized exploratory bases around 2045. By the 2090s, human settlements would likely emerge as political entities, reaching growth saturation by the 2120s. In comparison, Mars would see exploratory bases established from the 2090s onward, with human settlements as political systems forming from the 2160s or 2190s onward and achieving development consolidation by the 2230s. Partial terraforming could substantially improve access to the Martian surface by the 2230s or 2260s, supporting Martian independence between the early 2270s and early 2360s. Media content communicating these timeframes of lunar and Martian colonization realistically encompassed the movies Moon (2009), Ad Astra (2019) and the TV show The Expanse (2015-2022). Moon portrayed a specialized exploratory base around 2035, while Ad Astra showcased a Martian exploratory base alongside a lunar settlement functioning as a political entity in the early 22nd century. The Expanse presented an astro-political solar system -wide conflict between the Earth-controlled Terra -Luna system and a politically independent Mars around 2350.

Implications of the Study

For theoretical implications, this paper utilized Spengler's theory of Historical Cycles and its historical-comparativist method for the first time to address political questions regarding the temporal development patterns of Moon and Mars colonization, confirming this theory's applicability in the study context. This paper posited that creating analogies was the most useful approach in this context to attain verisimilitude, as it offered an improved long-term observational position encompassing centuries, thereby contributing new knowledge to the study subjects (Spengler, 1998).

This was the first paper applying Jenkins' theory of participatory culture to identify media content, such as movies and TV shows, that communicate realistic timeframes for Moon and Mars colonization. Based on the study's results, human Moon colonization was projected to occur between the 2020s and 2120s, and Mars colonization from the 2090s to the 2230s, carrying practical implications for national agencies and businesses involved in space exploration. While Moon colonization would likely raise geopolitical and economic questions before 2050, Mars colonization would not have practical implications until then, except for the first human landings necessitating temporary exploratory base creation.

Limitations and Recommendations for Future Research

The focus on Moon and Mars colonization timeframes intentionally neglected two other celestial bodies in the inner solar system, Mercury

and Venus. Due to its proximity to the sun and distance from Earth, Mercury was not expected to become a near or mid-future target for human settlements forming political entities. Venus, the planet closest to Earth, possessed extremely hostile climatic conditions, preventing any meaningful human access to its surface. Although its upper atmosphere offered the most hospitable conditions in the solar system outside of Earth, foreseeable future colonization of Venus' atmosphere through cloud habitats was unlikely (Doboš, 2023). Instead, humans would more likely settle in radiation-protecting lunar and Martian underground caves, following evolutionary patterns of a prehistoric past. The prospects of human presence on the Moon and Mars would require further studies, particularly regarding the impact of policies to be implemented by the U.S. Department of Government Efficiency starting in 2025.

Additionally, celestial bodies outside the inner solar system were also ignored in the study. While mining objects in the asteroid belt, forming the boundary between the inner and outer solar system, might become an important future industrial activity (Goswamy & Garretson, 2020), the low gravity of its asteroids would prevent establishing settlements as political systems comparable to those anticipated during Moon and Mars colonization. Furthermore, projecting the Roman-led expansion of the Classical world onto the Western settlement of the asteroid belt would be morphologically problematic, as no Classical territorial analogy to this belt could be identified with the same certainty that predetermined Classical Gaul and Britain as Western analogies to the Moon and Mars in the study context. The most suitable celestial object for extraterrestrial colonization in the outer and entire solar system, Saturn's moon Titan, with its dense atmosphere and methane resources (Zubrin, 2019), was left out of this study due to its far distance from Earth, drastically reducing human settlement prospects in the foreseeable future. However, future research should address the possibilities of settling Titan, as it offers in many ways the best conditions for humans living outside of Earth, should advancements in spaceship engine design make this distant world reachable.

Lastly, this paper focused on Western space colonization, as the political-comparativist approach of Historical Cycles could only be applied to still-developing high cultures such as the West. The West still had to move through the development phases of its civilizational winter, whose patterns allowed for an approximate predetermination of the next four centuries within limitations. Other space-faring civilizations, such as China, were neglected in the study context, except for direct responses to Western space exploration, as China had already completed its historical cycle about two millennia ago. Hence, Spengler's analogy approach, based on cyclical pattern repetition, was no longer applicable to contemporary Chinese developments. Also, it was the unique Western technology that enabled space conquest (Spengler, 1998, 2018). Non-Western space-faring cultures, such as the Chinese or Russians, only adapted Occidental technology out of necessity, responding to a Western power challenge, and would forget it after the West's demise in the early 25th century. Instead, they possessed due to their different cultural prime symbols, such as the predestined Chinese way through life, tao, or the Russian plain without limit, not the Western drive to develop it, as they lacked the Western longing for infinity (Ehret & Sani, 2022). An examination of especially Chinese space exploration efforts, comparative to the long-term analysis of Western efforts in this study, would be necessary, though it could not be based on Spengler's theoretical framework.

References

Alcock, J. P. (2011). *A brief history of Roman Britain: Conquest and civilization*. Hachette.

Alvarez, T. (2020). *The eighth continent: An ethnography of twenty-first century Euro-American plans to settle the Moon* (Doctoral dissertation, The New School). ProQuest Dissertations Publishing. https://www.proquest.com/openview/95e2de8e8c8e9fb9397908dcb3ff7d08/1?cbl=44156&pq-origsite=gscholar

Bedard, P. (2019, July 17). China to mine Moon, asteroids and races to be "#1 space power by 2045". *Washington Examiner*. https://www.washingtonexaminer.com/washington-secrets/china-to-mine-moonasteroids-races-to-be-1-space-power-by-2045

Broughton, T. R. S. (1951). *The magistrates of the Roman Republic, vol. 1: 509 B.C. - 100 B.C.* American Philological Association.

Broughton, T. R. S. (1951). *The magistrates of the Roman Republic, vol. 2: 99 B.C. - 31 B.C.* American Philological Association.

Brown, H. M., Boyd, A. K., Denevi, B. W., Henriksen, M. R., Manheim, M. R., & Robinson, M. S. (2022). Resource potential of lunar permanently shadowed regions. *Icarus, 377*(7), 1–22. https://doi.org/10.1016/j.icarus.2021.114874

Chavy-Macdonald, M. A., Oizumi, K., Kneib, J. P., & Aoyama, K. (2021). The cis-lunar ecosystem – a systems model and scenarios of the resource industry and its impact. *Acta Astronautica, 188*(11), 545–558. https://doi.org/10.1016/j.actaastro.2021.06.017

Dallas, J. A., Raval, S., Saydam, S., & Dempster, A. G. (2021). An environmental impact assessment framework for space resource extraction. *Space Policy, 57*(3), 62–73. https://doi.org/10.1016/j.spacepol.2021.101441

Doboš, B. (2022). Tortoise the Titan: Private entities as geoeconomic tools in outer space. *Space Policy, 60*(2), 1–9. https://doi.org/10.1016/j.spacepol.2022.101487

Doboš, B. (2023). *The geopolitics of space colonization: Future power relations in the inner solar system*. Taylor & Francis. https://doi.org/10.4324/9781003377252

Drinkwater, J. (2014). *Roman Gaul: The three provinces, 58 BC – AD 260*. Routledge. https://doi.org/10.4324/9781315796505

Ehret, M. (2022, June 1). Ad Astra – zu den Sternen [Ad Astra – to the stars]. *Akademische Blätter, 124*(2), 18–21. https://aka-blaetter.de

Ehret, M., & Sani, M. A. (2022). The impact of the Russo–Ukrainian War on Sino–German relations. *Contemporary Chinese Political Economy and Strategic Relations: An International Journal, 8*(3), 755–805. https://icaps.nsysu.edu.tw/p/404-1131-305796.php?Lang=en

Fenegan, S., & Styler, T. (Producers), & Jones, D. (Director). (2009). *Moon* [Film]. Sony Pictures Classics.

Foust, J. (2023, March 13). NASA planning to spend up to 1 billion on space station deorbit module. *Space News*. https://spacenews.com/nasa-planning-to-spend-up-to-1-billion-on-space-station-deorbit-module/

Gare, D., & Ritter, D. (2008). *Making Australian history: Perspectives on the past since 1788*. Thomson Learning.

Godfrey, W., Bowen, M., Klausner, I., & Chazelle, D. (Producers), & Chazelle, D. (Director). (2018). *First Man* [Film]. Universal Pictures.

Goswami, N., & Garretson, P. A. (2020). *Scramble for the skies: The great power competition to control the resources of outer space*. Rowman & Littlefield.

Grove, N. S. (2022). 'Welcome to Mars': Space colonization, anticipatory authoritarianism, and the labour of hope. In A. M. Agathangelou & K. D. Killian (Eds.), *Time, climate change, global racial capitalism and decolonial planetary ecologies* (pp. 217–232). Routledge. https://doi.org/10.4324/9781003278054

Holland, T. A. (2024). From Apollo to the ISS: The televisual image in human spaceflight. *Television & New Media, 25*(1), 57–73. https://doi.org/10.1177/15274764231177438

Howard, R., Grazer, B., Wilkes, J., & Kamen, J. (Executive Producers). (2016–2018). *Mars* [TV series]. National Geographic.

Jackson, N. (2022). *Trajan: Rome's last conquerer*. Greenhill Books.

Jenkins, H. (2009). *Confronting the challenges of participatory culture: Media education for the 21st century*. MIT Press. https://doi.org/10.7551/mitpress/8435.001.0001

Kinberg, S., Scott, R., Schaefer, M., Sood, A., & Huffam, M. (Producers), & Scott, R. (Director). (2015). *The Martian* [Film]. 20th Century Fox.

Klimchynskaya, A. (2022). Familiarizing the future: The diegetic prototype of Netflix's *Away*. *Science Fiction Film & Television, 15*(1), 81–91. https://doi.org/10.3828/sfftv.2022.6

Koch, J. S. (2018). Institutional framework for the province of all mankind: Lessons from the International Seabed Authority for the Governance of Commercial Space Mining. *Astropolitics, 16*(1), 1–27. https://doi.org/10.1080/14777622.2017.1381824

Mann, D. (2022). Red Planets: Cinema, deserts, and extraction. *Afterimage, 49*(1), 88–109. https://doi.org/10.1525/aft.2022.49.1.88

Martichoux, A. (2024, November 13). What is DOGE, the new department Musk and Ramaswamy will lead under the Trump administration? *The Hill*. https://thehill.com/homenews/4988711-what-is-doge-the-new-department-musk-and-ramaswamy-will-lead-under-the-trump-administration/

Matyszak, P. (2003). *The Romans in Gaul and Britain*. Thames & Hudson.

Moore, R. D., Davis, M., Nedivi, B., & Wolpert, M. (Executive Producers). (2019 – present). *For All Mankind* [TV series]. Apple TV+.

Moss-Wellington, W. (2020). Individual and collaborative labour in the space crisis movie: From *Apollo 13* to *The Martian*. *Quarterly Review of Film and Video, 37*(7), 634–657. https://doi.org/10.1080/10509208.2020.1731274

Nelson, J. W. (2020). The Artemis Accords and the future of international space law. *American Society of International Law Insights, 24*(31), 1–7. https://www.asil.org/sites/default/files/ASIL_Insights_2020_V24_I31.pdf

O'Brien, D. (2020). Legal support for the private sector: An implementation agreement for the Moon Treaty. *Advances in Astronautics Science and Technology, 3*(1), 49–64. https://doi.org/10.1007/s42423-020-00059-w

Pitt, B., Gardner, D., Kleiner, J., & Gray, J. (Producers), & Gray, J. (Director). (2019). *Ad Astra* [Film]. 20th Century Fox.

Robinson, K. S. (2015). *The complete Mars trilogy: Red Mars, Green Mars, Blue Mars*. Harper-Collins UK.

Ryan, M. H., & Kutschera, I. (2007). Lunar-based enterprise infrastructure – hidden keys for long-term business access. *Space Policy, 23*(1), 44–52. https://doi.org/10.1016/j.spacepol.2006.11.008

Schmidt, N., & Boháček, P. (2021). First space colony: What political system could we expect? *Space Policy, 56*(2), 1–10. https://doi.org/10.1016/j.spacepol.2021.101426

Shankar, N., Fergus, M., Ostby, H., Kosove, A., & Johnson, B. (Executive Producers). (2015–2022). *The Expanse* [TV series]. Alcon Entertainment; Amazon Studios.

Signatories of the U.S.-led Artemis Accords meet in person for the first time. (2023). *American Journal of International Law, 117*(1), 133–139. https://doi.org/10.1017/ajil.2022.88

Smith, M. (2024, January 9). NASA delays next Artemis missions to 2025 and 2026. *SpacePolicyOnline.com*. https://spacepolicyonline.com/news/nasa-delays-next-artemis-missions-to-2025-and-2026/

Song, H., Zhang, J., Ni, D., Sun, Y., Zheng, Y., Kou, J., Zhang, X., & Li, Z. (2021). Investigation on in-situ water ice recovery considering energy efficiency at the lunar south pole. *Applied Energy, 298*, 1283–1294. https://doi.org/10.1016/j.apenergy.2021.117136

Spengler, O. (1998). *Der Untergang des Abendlandes* [The decline of the West]. Beck. (Original work published 1918)

Spengler, O. (2018). *Prussian socialism & other essays*. Black House Publishing. (Original work published 1919)

Swan, P. (2023). Cooperation & competition. *Space Flight, 65*(6), 20–23. https://static1.squarespace.com/static/5e35af40fb280744e1b16f7b/t/647654b8615a7b1dda530078/1685476536916/spaceflight-june-2023-3-cooperation-and-competition.pdf

Taylor, A. (2013). *Colonial America: A very short introduction*. Oxford University Press.

Woodard, C. (2011). *American nations: A history of the eleven rival regional cultures of North America*. Viking.

Wu, Z., & Wang, Z. (2023). The rise and commonalities of Eastern and Western science fiction film and television. *Frontiers in Art Research, 5*(18), 6–10. https://doi.org/10.25236/FAR.2023.051802

Yap, X.-S., & Kim, R. E. (2023). Towards earth-space governance in a multi-planetary era. *Earth System Governance, 16*(2), 51–55. https://doi.org/10.1016/j.esg.2023.100173

Zubrin, R. (2019). *The case for space: How the revolution in spaceflight opens up a future of limitless possibility*. Prometheus.

Zubrin, R. (2021). *The case for Mars: The plan to settle the Red Planet and why we must*. Simon & Schuster.

