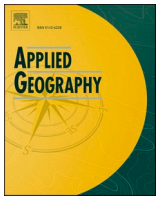
Applied Geography 187 (2026) 103887

Contents lists available at ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog



Bluetech in Baltimore: Co-creating smart city innovations with local youth

Michele Masucci [a,b], Dillon Mahmoudi [b], Alan Wiig [c,*]

[a] Vice Chancellor for Research and Economic Development, University System of Maryland, USA
[b] Geography and Environmental Systems, University of Maryland Baltimore County, USA
[c] Geography, University of Florida, USA

ARTICLE INFO

Keywords:
Artificial Intelligence
Baltimore
Bluetech
Digital divide
Innovation
Youth

ABSTRACT

This paper presents a case study of a climate-focussed digital internship pilot program intent on increasing engagement with, and jobs in, the "Bluetech" ocean-based economy in Baltimore, Maryland. Understanding participants' lived experiences across multiple strands of alignment–including general interest, digital skills and technology access, environmental knowledge, and perceptions of climate and environmental problems–supported their engagement in the program and advanced their educational and workforce goals. Those experiences are undergirded by the historical setting of Baltimore, which is navigating contemporary interrelated impacts of global change due to climate, economic, and digital infrastructure transformations. Like many cities, Baltimore has developed a policy agenda focused on technological innovation, sustainability, and education as conduits of progress meant to address these concerns. However, the promise of innovation across these policy areas may not be realized if Baltimore's youth do not attain the necessary digital competencies and relevant knowledge to address them. An iterative pedagogy was applied in order to help interns gain conceptual depth, technical skills, and content knowledge, and yielded insights about how youth may traverse the complexities of the modern Bluetech economy. Baltimore's innovation-forward policy agenda continues to require technology, education access and opportunity to connect to the economic directions being designed. And yet, the same advancement of innovation may also exacerbate the longstanding poverty present in the city if more is not done to bridge everyday experiences of youth with opportunities to learn and engage in foundational experiences, skills and knowledge upon which innovation will be based.

1. Introduction: Embedding smart innovations in the local, urban context

Like many cities, Baltimore has pursued smart city policies and programs that aim to improve the efficiency of its operations across many sectors of government. It has embraced digital services in governance, health care and education and supports infrastructure projects to overcome the ever-persistent digital divide of uneven access to technology, skills, and data. As noted by contributors to this special issue, such smart city projects have become commonplace over the last fifteen years in cities across the U.S. and globally. This has spurred a multitude of efforts to use digital innovation to address urban issues such as: engagement with civic governance systems; access to information and communication resources; access to tools and processes for entering the workforce; information about and access to education, healthcare, transportation, housing, recreation, and other municipal services; and access to emergency alert and response information—all of which increasingly rely on a network of public and private information and communication platforms in order to be utilized and accessed. In this paper, we approach urban innovation as an embedded process that starts "on the ground" with the experiences of residents in order to understand and address local needs via bottom up and participatory means, rather than the more-typical, top-down and expert driven process of implementing smart city projects (Masucci et al., 2020; Shelton et al., 2015). This theoretical underpinning is draws on the lessons learned from a youth program discussed in this paper to gain insights into how a bottom up process allows for both community inclusion in the design of digital innovations and builds agency in neighborhoods often disenfranchised from local politics, while also advocating that civic leaders and smart city planners understand the particulars of ongoing and often long-standing digital shortcomings facing working class urban neighborhoods.

This article is part of a special issue entitled: Urban Innovation in the Smart City published in Applied Geography.

* Corresponding author.
E-mail addresses: mmasucci@usmd.edu (M. Masucci), dillonm@umbc.edu (D. Mahmoudi), alanwiig@ufl.edu (A. Wiig).

https://doi.org/10.1016/j.apgeog.2025.103887
Received 13 June 2025; Received in revised form 18 December 2025; Accepted 22 December 2025
Available online 2 January 2026

Beneath the potential impact of technological innovations on so-called smart cities lies the everyday reality of integrating digital connectivity and digital literacies into typically-overlooked urban neighborhoods and communities. In many places, smart city innovations are not co-developed in partnership with the communities that will be impacted by the implementation, nor are they aimed at addressing the most pressing issues that many residents face. At the same time, the intractable challenges brought by occurrences beyond local control—such as climate change—often compound long standing, place-based social and economic inequities. Increasingly, this includes digital inequalities as well (Rydzewski, 2025), which in turn leads to an ongoing, and arguably accelerating, urban technological crisis, particularly for the most disadvantaged individuals and vulnerable communities.

Our focus in this paper is to consider how the emerging Bluetech sector exemplifies the ongoing challenges of digital inclusion in the context of Baltimore, Maryland. "Bluetech," the integration of digital technology innovations into the ocean-based, blue economy, can be thought of as the intersection between artificial intelligence and machine learning alongside environmental science and general digital literacy (Hotaling, 2021; Garland 2019). We use the example of development of the Bluetech economy in Baltimore, Maryland as a locally-specific, emerging context for examining why and how co-development of knowledge and solutions to local problems is such an essential part of the process of improving the viability and resilience of communities. We consider this through the lens of an out-of-school time internship program serving Baltimore youth, residents of the largest city situated on the Baltimore Harbor that is part of the Chesapeake Bay ecosystem.

Our approach to examining the iterative relationship between technology advancement and urban development was to evaluate this program: a climate-ready, digitally literate workforce internship focussed on increasing engagement with, and jobs in Bluetech as an emergent sector of the city's economy. The program framed innovation via the ability of digital technologies to address existing—and potential future—community concerns, whether these concerns centered on smart city technological change or not. It introduced core concepts about the blue economy, youth-centered learning journeys, and the design of a digital game-simulation as an iterative, hands-on learning approach to tackle the complex relationships across the local impacts of climate change, resilience and mitigation, and analytical and digital skills development. The program, designed as a pilot to examine the usefulness of this youth-centered learning approach, was evaluated following the methods established in earlier work (Masucci et al., 2020). The goal of the evaluation was to learn whether or not such an approach would engage youth to want to learn more about the Bluetech economy and whether or not they envisioned their ability to participate within it. The core elements of the evaluation included implementing a concept map to identify their base understanding of ocean-focused technology in Baltimore, followed by a youth-centered approach to learning basic information about it. We in turn prepared and coached participants on the design and implementation of a game simulation to teach the concept to others, and a series of sessions unpacking their progress that also assessed their interest and engagement throughout. The students concluded their time in the program by redesigning their original concept maps and demonstrating their games to the group. Ultimately, the student-designed game apps revealed the participants' respective understanding of Bluetech in the context of Baltimore's economy and relationship to the ocean. Their discussions of the game apps became a means of establishing what the students learned and how they conceptualized Bluetech (and the digital underpinnings of the economic sector) itself. Lastly, we held a follow up discussion session with students at the end of the program in order to learn more about the value of this approach from their perspective and their thoughts about scaling the program to a larger cohort and broader array of the environmental challenges facing Baltimore.

Baltimore's identity as a quintessential blue economy city is rooted in its harbor on the Chesapeake Bay, historically one of the most productive estuaries in the world. As a key port city, Baltimore was not only a national hub for shipping and industry but also a center for oyster harvesting, shipbuilding, and marine trades that supported both regional livelihoods and Atlantic Ocean commerce. Its development as a maritime commercial and ecological hub co-evolved with its growth into an industrial urban center, shaping its socio-economic and environmental fabric (Fee et al., 1993; Liebel, 2006). Contemporary Baltimore is grappling with how to define and provide a platform for a new blue economy that is digitally and technologically powered while simultaneously confronting both the need to adapt the city to extreme weather and sea level rise as well as building a more-resilient economy via jobs in sectors such as offshore wind energy, aquaculture, and watershed restoration. Against this backdrop, educators are trying to prepare youth to navigate their future pathways despite persistent digital inequality and an increasingly complicated set of knowledge systems they need to engage and master.

Baltimore's smart city and Bluetech sector initiatives serve as a context for understanding the issues surrounding digital inclusion and innovation. We will describe how we co-designed the pilot "BlueTRIP" internship program for youth in Baltimore to better understand the way they framed their understanding of the technology they use in the dual contexts of education and work connected to the blue economy. Our aim is to explore the iterative nature of digital and workforce exclusions as the city grapples with challenges its residents face to connect technological skills with education and workforce goals and to stimulate new areas of innovation to secure the city's "smart" future. Urban policy and urban development issues are deeply connected to both, whether they pertain to new plans in the central Inner Harbor and Harbor East locations, the implementation of smart transportation technologies citywide, and upgrading transportation hubs to connect neighborhoods to commercial districts more efficiently, or Baltimore's digital education efforts through libraries, aging and workforce development service providers.[1] Further, while beyond the scope of this paper, the rise of Bluetech highlights an element of the digitization of the ocean and the integration of 'smart' technologies in ocean governance.

2. Background: Bluetech and Smart City Baltimore

Baltimore has experienced nearly half a century of urban revitalization efforts but also persistent poverty, disinvestment, and industrial decline (Fee et al., 1993; Liebel, 2006; Glotzer, 2020). The result of this duality is a fragmented geography of innovation superimposed onto stark patterns of racialized, socio-economic inclusion and exclusion (Aufseeser and Mahmoudi, 2025; Brown, 2021; Pietila, 2010). Since the 2008 global financial crisis, Baltimore, like many cities, has pursued a strategy of improving digital connectivity and smart city initiatives to support its economic revitalization efforts. Included within this approach is the implementation of digital education initiatives, platform-based service provision, and investments in tech-driven economic sectors (Lung-Aman et al., 2021). In Baltimore, these strategies have failed to fully address the everyday realities of digital (in)access and digital (il)literacy, particularly in low-income, often non-white, communities that have long been marginalized. For instance, Iyer (2015) identified how uneven data sharing capabilities led to stakeholder representation issues in citizen data reporting programs like WatershedStat and CitiStat in Baltimore (see also Horrigan, 2020). Baltimore's experience exemplifies the tensions inherent in smart city development, where innovation is layered onto existing inequalities, raising concerns about who ultimately benefits from these urban technological transformations.

[1] Source: https://www.baltimorecountymd.gov/departments/information-technology/digital-equity/literacy Accessed 27 February 2025.

At the same time, climate change is impacting the city in dramatic ways. Sea level rise is predicted to increase at an accelerated rate in the coming decades (Boesch et al., 2018; Najjhar et al., 2010). This will in turn cause higher levels of water in the Baltimore Harbor at high tide, storm surges, and an increase in flooding events (Boesch et al., 2018). These events happen primarily via microclimate heavy rainfall events that are causing basements to flood and the sanitary sewers to overflow (Najjar et al., 2010). The city and its harbor is also projected to experience increases in coastal flooding spreading into low lying neighborhoods (ibid). In addition to sea level rise and increased rainfall, Baltimore is projected to have a steady increase in temperature as well. Higher temperatures result in heat waves that can affect public health and feed the cycle of higher sea levels and a warming ocean, compounding and accelerating the impact of climate change in the city (Parsons et al., 2024). Baltimore's Office of Sustainability recognizes the potential impacts of these changes and the costs associated with mitigating these effects, including increased energy demand to address higher temperatures; hazard responses to mitigate the impacts of rainfall events and deal with more dramatic fluctuations in rainfall; impacts to the species within ecosystems as well as overall ecosystem strength and viability; longer heat waves and increased instances of human health responses like respiratory illnesses as a result of them (City of Baltimore, 2025).

Taken together, we consider that one of the city's most pressing contemporary challenges lies at the intersection of urban resilience, climate adaptation, economic restructuring as well as education, dramatically illustrated by the March 2024 collapse of the Francis Scott Key Bridge spanning the harbor on the city's edge. The collapse was caused by the accidental collision of a cargo ship named Dali with one of the bridge supports when it left Baltimore Harbor (NTSB, 2024). The collision resulted from a power malfunction on the ship (ibid). This collision caused the bridge to collapse into the Patapsco River almost immediately and caused the deaths of six workers who were making repairs to the bridge road at the time of the collapse (ibid). The collapse immediately blocked all water transportation in and out of the harbor due to the structural damage caused to the bridge and the inability of the Dali to move. It also cut off transportation on a heavily used local and regional route used by over 12 million vehicles each year including the transport of hazardous materials around the city of Baltimore (MCC, 2024). This disaster not only highlighted urgent infrastructural and environmental concerns, but it also revealed competing visions for rebuilding. Labor groups emphasized the need for long-term job security and equitable recovery, while investors and developers favor rapid, profit-driven reconstruction that may exacerbate Baltimore's existing social and economic inequities (Jordan, 2024; Lopez, 2024; Wood & Zawodny, 2024). Historically black communities that relied on the bridge to travel to navigate the region for work and access to commerce were now cut off and further isolated from economic opportunities (AP 2024).

The shipping industry at the center of the bridge collapse, and the harbor's logistics sector more generally, illustrate what goes wrong when there is a lack of alignment between transportation and other technologies. While the failure of the bridge structure was due to the direct impact of the Dali, the collapse highlights how basic communications are still fundamental in complex systems—like the use of a mayday signal from the ship to authorities on the ground moments before the collision allowing just enough time to halt traffic but not enough to reach the workers already in place on the bridge (Schapiro and Schuppe, 2024). The tensions surrounding the immediate and long term response to the collapse are strikingly similar to those that emerge more broadly in the implementation of smart city initiatives, where technological solutions are often introduced without meaningful engagement from the communities they aim to serve. As with the divergent approaches to reconstructing the bridge, smart city programs frequently privilege efficiency, investment, and economic growth at the expense of local needs, thereby reinforcing, rather than addressing, structural inequities (Pietila, 2010; Brown, 2021).

The release of Baltimore's Digital Strategy, also in 2024, attempted to respond to the city's technological disparities, yet data show that deep digital divides persist, limiting the effectiveness of smart city interventions in fostering inclusive economic and social resilience. As of 2023, 73.3 % of white households in Baltimore had wired broadband access, compared with only 50.2 % of Black households and 46.4 % of Hispanic households (City of Baltimore, 2024, p. 4). Similarly, 80.7 % of white households owned desktop or laptop computers, compared with 60 % of Black households and 47.5 % of Hispanic households. The digital divide not only limits economic opportunities, but also exacerbates the city's vulnerability to crisis, as access to digital tools are increasingly necessary for the city's agenda for resilience planning, emergency response, and workforce development (City of Baltimore, 2019).

Yet these divides cannot be understood in isolation from Baltimore's long history of racist policies and investments that structured the city's geography. In the late 1800s, wealthy investors—whose fortunes were tied to slavery and colonization—laid the groundwork for exclusive, predominantly white enclaves through racial covenants and redlining (Pietila, 2010; Glotzer, 2020). This legacy produced a “Black Butterfly” effect, consigning Black communities to entrenched disinvestment and limiting access to education, employment, transportation, and healthy food (Brown, 2021). In this deeply segregated context, digital infrastructure is yet another frontier where unequal investment and systemic barriers continue to shape residents' life chances.

These disparities are not unique to Baltimore but mirror broader structural inequalities in digital access across urban and rural geographies. While rural areas often experience infrastructural disadvantages that limit broadband expansion, urban areas like Baltimore face a different but equally significant challenge: systemic disinvestment and digital redlining that disproportionately affect communities of color (Brown, 2021). Smart city initiatives tend to prioritize technological innovation as a driver of economic growth, yet they frequently neglect the foundational issues of affordability, access, and digital literacy (Greene, 2021). Without intentional efforts to co-develop these technologies with marginalized communities, smart city strategies risk reinforcing rather than alleviating social inequalities. The uneven integration of digital infrastructure into everyday life means that, rather than fostering inclusive economic development, these projects may instead deepen existing patterns of exclusion, leaving behind those already disadvantaged by broader economic and environmental crises.

Specific smart city initiatives in Baltimore, like one run by the state of Maryland's Center for Smart Growth, revealed that, fundamentally, Baltimoreans in places such as West Baltimore still struggle to access stable housing, reliable transit, equitable schooling, and other necessities (see Lung-Amam, 2021). No matter how advanced the urban technologies—be they ‘smart’ trash cans or real-time data dashboards—these systemic challenges remain rooted in a history of segregation, public and private disinvestment, and discriminatory lending practices that newer digital fixes alone cannot address (see also Wiig and Masucci, 2020). Residents recounted how high-tech cameras or shot-detection systems do little to address the ongoing lack of job training, affordable broadband, or safe public spaces, leaving them subject to the same structural barriers that shaped their neighborhoods decades ago. Indeed, the trust gap between communities and government agencies—exacerbated by repeated policy failures—means that many Baltimoreans experience so-called ‘smart’ interventions as yet another top-down project that overlooks daily realities like food insecurity and underfunded schools. In short, while ‘smartness’ may streamline municipal services, its reliance on shiny digital investments without matching commitments to affordability, employment, usability, and community-led decision-making ultimately leaves behind those already marginalized by Baltimore's entrenched inequalities (e.g. Park and Vitak, 2024).

In other words, effective smart city innovations must be anchored in

the everyday realities and knowledge of local residents, regardless of where in the world these innovations are deployed. This sort of grounded, embedded approach to both studying and prototyping smart city innovations has progressed across the global South (Alizadeh and Prasad, 2023; Guma, 2025; Guma and Wiig, 2022) and North (Masucci et al., 2020; Miller et al., 2021). Community-led, contextualized technological interventions in peripheral, marginalized, and/or disenfranchised neighborhoods—interventions that match the pace of innovation to local priorities whether in cities of the global South or North—help ensure that "smartness" serves the people most impacted by inequality. It is precisely this alignment between evolving technologies and actual community needs that underpins the effort to situate the Bluetech sector within a smart city urban innovation framework. In so doing, this may ensure the technologies are contextually relevant to the work environment even if, as we found in Baltimore, the location's needs are quite different from the concerns of smart city developers emblematic in Silicon Valley, Seattle, New York City, Boston, and other hubs of U.S. tech innovation (Zukin, 2020). If Baltimore's workers cannot attain the necessary digital competencies and adequate knowledge of artificial intelligence and machine learning alongside environmental science and general digital literacy, the STEM skills relevant to Bluetech, then the sector's integration into the local economy may exacerbate the long-standing poverty and political disenfranchisement already present in the city.

3. Designing a Bluetech Internship Program with Baltimore Youth

To better understand how Baltimore's economic growth ambitions interrelated with educational preparation for students experiencing digital inequalities, we created a pilot program to explore youth experiences with and perspectives on the connections between their lives, environmental science, and digital and emerging technologies such as artificial intelligence and machine learning. The pilot we implemented in the Summer of 2023 drew on Baltimore's historic context outlined above as well as a consideration of the contemporary importance of the blue economy and digital innovation and policy drivers. The program fostered a small number of internship experiences that immersed participants in the parallel tracks of gaining digital skills, learning about the blue economy in Baltimore, and applying those skills to develop a blue technology intern-designed project. We quickly identified that internship participants had limited prior experiences to draw upon to connect the digital skills focus they had developed through their lives thus far with the types of content knowledge, education and career directions, and application of skills to real-world problems that would be essential to ultimately connecting with the local blue technology workforce.

Our focus on blue technology jobs as the connector to applied digital skills stems from the Baltimore economic development context. We note that since the turn of the century (and increasing significantly during the post-Covid economic recovery) there is growing local as well as worldwide recognition of the important role that Bluetech can play in revitalizing the economies of coastal regions (see e.g. Brush, 2022). At the same time, policymakers recognize that ensuring a competitive, qualified Bluetech workforce necessitates training in 21st century digital literacies alongside increased familiarity with Bluetech itself (TAFE Directors Australia, 2020). There are numerous Bluetech clusters across the North Atlantic and specifically located in Baltimore - like the University System of Maryland's Institute of Marine and Environmental Technology (IMET), located on Baltimore's downtown waterfront, which hosts the largest such cluster in the Mid-Atlantic (The Ocean Foundation, 2023).

As a workforce education issue, ensuring that workers are adequately trained to participate in future work such as in Bluetech necessitates engaging with the emergent workforce directly. There are pedagogical models for doing so in similar US cities like Philadelphia (Masucci et al., 2016) via digital inclusion and urban, geographic fieldwork, that were applied here. Long term partnerships with industry experts can be beneficial connecting youth to the real world implications of STEM learning via teaching job skills for relevant industries in the classroom (Watters and Diezmann, 2013). Furthermore, the cultivation of a "STEM-capable workforce" (STEM stands for science-technology-engineering-math) is grounded in the need for greater integration of innovative and timely STEM education in K-12 curricula via stronger partnerships with universities in order to ensure the U.S.'s continued competitiveness in the global economy (National Academies of Sciences, Engineering, and Medicine 2016).

Within the Bluetech-STEM workforce development ecosystem in Baltimore, two sectors have stood out: offshore wind energy and oyster aquaculture for water health and sustainable seafood production (Bluetech MD 2021; IMET no date; Oyster Recovery Partnership, 2025). Across these sectors, the integration of artificial intelligence and robotics into the work of monitoring operation and maintenance has increased in recent years. For instance, scholars note that robotics and artificial intelligence will evolve into "surveying, planning, design, logistics, operational support, training and decommissioning" of offshore wind energy infrastructure and that there is a need for workers to be trained in "human-machine interaction" with autonomous systems (Mitchell et al., 2022, p. 1). The applicability of artificial intelligence for oyster aquaculture extends from using it to monitor remote sensing data of water quality throughout the Chesapeake Bay watershed (Uz et al., 2020; see also Bruce et al., 2021), to automating decision making around "feeding, disease treatment, and breeding" as well as robotic management of fisheries (Daoliang and Chang, 2020, p. 1), to managing physical and biological sensors for algorithmic monitoring of water quality (Sharma and Kumar 2021). These developments raise new governance challenges, as oversight bodies must now contend with regulating not just ecological impacts but also the deployment of opaque, data-driven systems across marine environments. Just like with smart city governance (Wiig, 2016), ensuring accountability, transparency, and equity in the use of AI and robotics in Bluetech sectors will require updated regulatory frameworks, cross-sectoral coordination, and mechanisms for public and worker engagement in algorithmic decision-making processes.

By bridging between STEM educators, Bluetech industry professionals, and university scholars, digital workforce development platforms have the potential to co-create industry-relevant knowledge and critical thinking about future work and future technology among the young people who potentially could fill positions in these emergent fields. In Baltimore and the greater Chesapeake Bay region, "field-based and hands-on experiential learning" has been shown to heighten K–12 students' enthusiasm for STEM (O'Neil et al., 2020, p. 14), ultimately fostering an environmentally literate population capable of navigating the challenges facing urban harbors. Our experiences affirm (Authors - citation will be added after review) that creating direct relationships with youth—particularly those from communities historically disconnected from their urban environment—helps them recognize real-world applications of STEM and envision tangible career pathways.

Building on these insights, the program we piloted in 2023 was designed to spark local youth engagement within Bluetech, broaden their digital competencies, and, ultimately, strengthen their sense of efficacy regarding future employment in this rapidly evolving sector. Our pilot built on 25 years of prior experience implementing digital skills and workforce development programs in Philadelphia and lessons learned implementing an online version of that program necessitated by COVID (Authors - citation will be added after review). This prior work showed the importance of gaining insights about how youth use digital technologies and develop innovative and creative solutions to engage in learning experiences. However, we had not implemented a curriculum that introduced digital and other STEM skills alongside environmental knowledge systems and related technologies relevant to Baltimore's economic and environmental context. Doing so provided an opportunity to examine how such conditions could lead to an internship experience

that would combine the use of both skill and knowledge sets.

During a five-week period in the Summer of 2023, we implemented this pilot program - called Blue Technology Research Internship Program (BlueTRIP) - to engage interested Baltimore youth in implementing a hands-on research project using digital technologies. The program involved four youth as interns, ranging from high school to junior college in educational experience, with the assignment of preparing educational information resources connected to Maryland's blue economy. All were African American, three were male. The three male interns completed the entire internship; our female intern switched from our program to an in-person program due to lack of regular access to technology resources needed to participate in the program. The small scale of the pilot was due to: a) the limited number of Baltimore youth engaged in the YouthWorks program generally, that also had the means to participate via an online format, b) the initial interest in the topic, and c) the time commitment needed to complete the tasks.

The task of the internship experience was for interns to create educational materials that could be used by peers to learn about what the blue economy is, specific jobs within this sector, skills needed by those jobs, and strategies for communicating that information to prospective students. The program participants were financially supported by the Baltimore YouthWorks program, which provides wages to students for structured experiences. Their aim is to support youth "to collaborate with youth and employers to create a meaningful paid employment opportunity that enhances youth job skills" (Mayor's Office of Employment Development, 2023). YouthWorks is a longstanding Baltimore initiative connecting thousands of young people (ages 14 to 21) with summer employment in various industries, thereby fostering essential career skills and workforce readiness (Mayor's Office of Employment Development, 2023). Building on this model, our program employed an iterative, project-based learning approach—underpinned by scaffolded instruction—to guide interns from an initial lack of familiarity with the Bluetech sector to the creation of meaningful projects for their peers. In practice, "iterative" meant continuously assessing and adjusting learning objectives based on interns' readiness; "scaffolded" referred to introducing new content and skills precisely when participants needed them; and "project-based" emphasized co-defining topics that resonated with the interns' own interests and community contexts.

Interns met online each day with one of three scholars guiding the program to work through a series of assignments aimed at providing a context for their role in helping to develop information materials about the Bluetech economy. This involved a preliminary assessment of their backgrounds related to the themes of the program using a concept map approach aimed at gaining insight about their prior knowledge related to the blue economy and Bluetech in particular. The concept map was a key component in the program evaluation method, in that it served the purpose of establishing their baseline knowledge about Bluetech as well as the beginning point for tailoring the curriculum to their interests. We also assessed technology access and digital skills to learn what approach to information delivery, discussion, and project development would work best. The interns used these new skills to explore background information and the technology orientation they would need in order to move forward to accomplish that goal. We learned quickly that the interns would need to gain core concepts related to multiple facets of the project in order to proceed, including backgrounds in Baltimore's history, ecosystems, and economic system. We also provided instruction on the use of Zoom, PowerPoint presentation development, report writing, using on-line information sources, and ultimately, online game platforms. We learned from the interns that their view was the best way to inform other youth about Bluetech was to design a game as a vehicle for providing a systems understanding of it. As a result, we also provided a background on games as a learning device and construct for analyzing how complex systems function.

This pilot internship assigned participants the role of research assistants focused on examining and expanding knowledge around Baltimore's emergent Bluetech economy. Following a "Learn → Teach → Learn" model, the Blue Technology Internship Program (Blue Trip) was designed so that interns acquired foundational concepts and digital skills, then immediately applied and shared that knowledge, thus reinforcing their own understanding. As a hands-on learning program, its evaluation included tracking how participants integrated new ideas regarding the blue economy into local environmental and social contexts. As noted above, the interns' progress was measured through pre- and post-experience concept maps, which captured shifts in their understanding over the course of the five weeks. Their learning process was guided largely by the US National Oceanic and Atmospheric Administration's curricular information and additional web-based resources (NOAA, 2021).[2] Structured as iterative, scaffolded, project-based learning, the internship ultimately led the group to choose game design as a practical vehicle for explaining the complex "systems thinking" behind Bluetech. This decision emerged organically from the interns' preferences and experiences, demonstrating how an active, learner-centered approach can foster genuine engagement and creativity in addressing real-world economic and environmental challenges.

4. BlueTRIP: The Blue Technology Research and Internship Program

With encouragement from collaborators based at the University of Maryland's Center for Environmental Science's Institute of Marine and Environmental Technology (IMET), the interns engaged with guest speakers and videos about climate change, oyster cultivation, horseshoe crabs, offshore wind, and the broader ecosystems of the Chesapeake region. Their growing awareness of watershed functions and ecosystem management catalyzed weekly discussions regarding Maryland's future, culminating in more sophisticated conversations around environmental justice, unevenly distributed ecological burdens, and the intersection of social and environmental challenges. This combination of structured guidance, real-world examples, and reflective dialogue enabled the participants to deepen their understanding of the blue economy, while also expanding their capacity to recognize and critically assess complex societal and environmental issues that shape Baltimore's development trajectory.

Building on the intern cohort's new knowledge of the Chesapeake Bay's ecology and the broader blue economy, we next introduced the concept of using "persuasive games" (Bogost, 2010, 2021) as a tool for outreach and education. Persuasive games refers to games that use the unique properties of the medium—its rules, mechanics, and interactive elements—to make an argument or convey a message. Rather than simply delivering information through narrative or graphics, persuasive games integrate meaning into the very structure and design of gameplay, thereby shaping players' experiences and potentially influencing their perspectives on issues ranging from politics and economics to social or environmental concerns. A core mechanic is that because games are procedural—relying on rules and dynamic systems to create gameplay—they can form a special type of "procedural rhetoric" (Bogost, 2010) capable of challenging assumptions and fostering deeper understanding in players.

[2] See also: https://oceanservice.noaa.gov/economy/blue-economy-strategy/Accessed 27 February 2025.

Participants first engaged with core ideas about the blue economy—focusing on local environmental and economic systems in Baltimore—and examined examples of "blue jobs," where marine science, technology, and conservation intersect.[3] To illustrate how these disparate elements could be woven into a cohesive narrative, we guided discussions on conceptual models depicting the integrated nature of Bluetech. Alongside their growing familiarity with environmental processes, the interns also explored how data—ranging from wildlife ecology metrics (e.g., bird population studies) to climate-change indicators—can inform both regional policies and game design.

With these building blocks in place, interns turned to the creation of "Blue Techquity" browser games, using FlowLab.io to translate their newly acquired insights into interactive, web-based experiences. Through iterative, project-based learning, they narrowed down the broad themes of climate change, environmental justice, and technology-driven job growth to specific, youth-relevant topics they felt warranted attention from peers and policymakers. Trained on basic principles of game design and supported by real-world facts and figures, the interns integrated key messages into "problem-based learning" scenarios, intentionally aligning gameplay elements with the persuasive aim of educating and inspiring action. Each intern designed their own game and all provided feedback related to the design. The process of game development included learning the content about the ecological or Bluetech problem engaged by the game, determining a game approach, learning how to use FlowLab.io as a design tool, creating a narrative description and "lore" related to the game, and developing a game prototype. By presenting their games to one another and refining the prototypes through peer feedback, they demonstrated how a playful, digital medium can both enhance understanding of complex social-environmental issues and invite players—especially other youth—into meaningful reflection on Baltimore's evolving Bluetech landscape.

5. Persuasive Bluetech games

Two games designed by the interns illustrate the heavy influence their prior gaming experience had in shaping their peer-to-peer approach to introducing others to the Bluetech economy. Two games were developed using Flowlab.io, a third was described as a board game and less complete by the end of the program period. The two computer based games were called "Nutria Hunter" and "Oyster Rush."

5.1. Nutria Hunter

"Nutria Hunter" was designed as a four player game to address the problem of invasive species that could arise as a result of ecosystem changes in the Baltimore area due to rising temperatures, increased rainfall, and the impacts of sea level rise. In "Nutria Hunter," players pilot a boat equipped with a net gun, aiming to remove nutria—a destructive, rat-like invasive species—from the coastal environment. Set against a backdrop of marshy wetlands, the core mechanic involves shooting nets at nutria while carefully avoiding native wildlife like horseshoe crabs, oysters, fish, and birds. As the game progresses, nutria move faster and appear in higher numbers, reflecting the real-world difficulty of eradicating invasive populations. However, successfully capturing nutria results in a visibly healthier ecosystem on-screen, reinforcing how controlling invasive species helps restore habitats for native plants and animals. By coupling these procedural challenges with tangible visual feedback, the game embodies a "persuasive" element: players experience firsthand the impact of invasive species, gleaning an implicit argument for ecological preservation and community-based environmental stewardship.

5.2. Oyster Rush

"Oyster Rush" was a single player game, designed as a side-scrolling platformer reminiscent of classic Nintendo Mario games, but with a marine twist. Players navigate a coastal landscape as water rises from the bottom of the screen—an escalating hazard that symbolizes the creeping threat of climate change. As they leap across obstacles, they collect items needed to build and maintain oyster reefs—critical natural barriers for flood mitigation. Failing to gather enough key resources (or move quickly enough) leaves the area increasingly inundated by floods, highlighting the urgency of timely, coordinated intervention. This dual emphasis on agile movement and resource-gathering demonstrates how oyster reefs not only bolster coastal resilience but also require sustained human effort and planning. In doing so, the game's "persuasive" dimension becomes clear: by mirroring real-world environmental stakes in its mechanics, "Oyster Rush" invites players to reflect on the importance of investing in ecological infrastructure and collective climate adaptation strategies. It also captures the urgency of decision making in a rapidly transforming environment. The player has to learn what the effects are at each stage to prepare for the increased intensity of the rising sea.

6. Analysis: Rethinking innovation among new digital divides

Our evaluation of the impact of the internship as a means of engaging youth in the Bluetech economy involved them completing a concept map of their initial understandings related to the blue economy and a follow up concept map at the end of the program. It also included gathering ongoing feedback during weekly wrap up sessions that examined the development of their game projects. In addition, we held a final session with youth to learn about their perspectives related to the program as a whole. Separately, Youthworks Baltimore also did periodic assessments of the program to ensure interns were engaged, performing their work assignment, and benefiting from the experience. These assessments were all qualitative in nature but highlighted separately some consistent themes. First, the three interns who completed the entire program were engaged every day during the program, worked independently on their game development, and produced projects that were aimed at engaging peers in their topics. Through using a game development project, we learned from the interns what they were interested in and leveraged that to help solidify their understanding of core concepts related to the environment and the blue economy. By using a technology and information-rich approach to providing content related to basic concepts related to the blue economy and technologies associated with it, interns shared with us that they realized by the end of the program that they did not have the prior exposure to the depth of information needed to apply the technology skills they did possess.

Second, we learned that by meeting interns where they were in terms of conceptualizations of the blue economy as depicted in their initial concept maps, we could tailor information about economic and environmental systems, information about the blue economy on a global as well as local basis, and information about specific problems related to blue economic systems to their interests. This translated into using lots of local examples to illustrate core concepts and using interactive data sets to illustrate information about environmental and economic systems. Interns and specialists reviewed content together on Zoom, allowing for a more interactive approach to content mastery as well as the opportunity to learn about intern points of view related to the

[3] Curriculum included: Introduction of core concepts of blue economy and blue technology; the ecology of Chesapeake Bay region, specifically that of Baltimore itself; wildlife ecology—birds and birds as examples of how data is used in examining environmental processes; films related to environmental problems; an examination of models to depict the systemic nature of blue economy, and the development of participants' own conceptualizations that formed the basis for their projects (i.e. basis for asking questions to learn more); blue economy and Bluetech jobs; game design and game examples; game technologies; facts and figures about topics of interest related to the themes of the internship.

applicability of information to their own communities and daily lives. Each session also involved work on their games, including having interns identify games, game strategies, and game prototypes that could be used as inspiration and models for their own design process. This allowed them to develop and demonstrate mastery of digital skills needed to create the game, knowledge of the environmental concepts and systems embedded within the games, and technical guidance on how to design games.

Finally, we learned how critical it was to provide expert knowledge and technical support to tackle the complexity of building digital skills, learning about economic and environmental systems, gaining an understanding of the blue economy, and game design. We followed this complexity because it is what the interns ultimately wanted to do—design games, something that leveraged their digital skills. In order to do that effectively, we needed to help them quickly fill in the conceptual and topical knowledge to apply those skills in a meaningful way. So, we provided technical support and guidance, which included coaching interns to develop a storyboard to depict the progress of the game, determining the rules of the game and explaining how it would be played, creating lore related to the game to orient players to the game context, and evaluating progress on content, technical development, and the user experience with the game. This involved an iterative, intern-centered approach to guide interns to continually interrelate digital skills associated with accessing content and information related to their game with content and understandings associated with economic systems and the blue economy. Through these interactions, interns developed more comprehensive concept maps of the blue economy and depicted how that would inform their game design. The new concept maps were presented in powerpoint form and discussed by the group at the end of the internship period. Their games further demonstrated a working knowledge of the blue economy as a driver of game design.

7. Conclusion

Three key takeaways from the Bluetech Internship Program (Blue Trip) included: a) the deep and persistent digital access challenges faced by youth; b) the striking need for digital skill development to be co-developed with specific content and knowledge systems; and c) the critical need for teachers, mentors and coaches to provide forums for deep engagement of those intersections. The interns in the program all had strong digital skills despite huge challenges in accessing the internet, particularly at speeds high enough to utilize large data sets and websites that required significant processing power. Connections to the internet could be intermittent or only through a smartphone, someone might be borrowing a friend or neighbor's laptop, and/or a quiet room and a desk to work at could be difficult to reliably access. They relied on old or unreliable equipment, lacked continual and unimpeded access to the internet, and often shared resources with family members. The gap between the physical environments interns had to use digital technologies and those of the scholars involved in the program highlight not only the deep and persistent digital divide issues that face youth from underserved communities, but also the need to understand those challenges when developing programmatic efforts from the context of more ubiquitous and relatively higher levels of access. Using games helped reduce the barrier of science as a gateway to understanding the complexity of water ecosystems and the blue economy, but it introduced other technical knowledge and platform gaps. For example, while a smart city, digital workforce education platform such as that discussed in this paper can provide information, training, and other resources, a mismatch between these innovations and participants' ability to access these innovations remains.

The implementation of this program highlighted the extreme complexity of connecting the seemingly common sense and ubiquitous policy goals of advancing digital innovation with locally specific and responsive economic development goals. In the case of Baltimore, those economic development goals are closely connected to the environmental context and problems facing the city. The Blue Tech pilot internship program offered important insights into the invariably interconnected and mutually constituted ways in which the educational environment, skills and knowledge, and local context shape the opportunities available to those seeking to advance their education and pursue jobs and careers that may be of interest. Age-old questions persist for the interns with whom we worked. How would one know about the blue economy and blue technology job trends without very specific access to a program that introduced these themes, despite living in a local economic context that is imbued with those exact choices? How can youth apply the core digital competencies they have developed through their formal education to specific sector-related problems when they lack access to information and experts who can help them understand those particular applications? How will a city like Baltimore ensure citizens apply digital skills and specialized knowledge to the specific economic problems it faces based on its unique history, location, and place-based context for development?

The paper aimed to examine these themes and questions through the pursuit of the dual strands of evaluating the learning context and lived experience of program participants with the intersecting problem of understanding the uneven geographies of place-based technology innovation. An evaluation of the program's project learning outcomes emphasized how the value of drawing on participants' local knowledge of place can be used to scaffold knowledge about climate and climate impacts, particularly as applied to culturally and locally relevant concerns they identified. It also provided a means of understanding urban technologies and related sectors of the innovation economy as well as how program participants connected their digital knowledge and experience to smart city platforms for their education and job opportunities. Lastly, we also showed how important it is to understand the lived experience of city residents within which multiple strands of alignment such as interest, digital skills and technology access, environmental knowledge, and perceptions of climate and environmental problems can be related to–and incorporated within–digital education programs, and smart city innovations more generally.

CRediT authorship contribution statement

Michele Masucci: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Dillon Mahmoudi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Alan Wiig:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Alizadeh, T., & Prasad, D. (2023). The right to the smart city in the global South: A research agenda. *Urban Studies, 61*(3), 426–444.

Associated Press (AP). (2024). A historically black community grapples with lasting impacts after Baltimore bridge collapse. October 18, 2024 https://www.nbcnews.com/news/nbcblk/historically-black-community-grapples-lasting-impacts-baltimore-bridge-rcna176143. (Accessed 28 February 2025).

Aufseeser, D., & Mahmoudi, D. (2025). Interrogating narratives of urban change: Disinvestment and development in two neighborhoods in Baltimore, MD. *Urban Geography, 46*(3), 589–611.

Bluetech Maryland. (2021). Blue nexus. Source: https://www.Bluetechmd.com/blue-nexus-event. (Accessed 23 February 2025).
Boesch, D. F., Boicourt, W. C., Cullather, R. I., Ezer, T., Galloway, G. E., Jr., Johnson, Z. P., Kilbourne, K. H., Kirwan, M. L., Kopp, R. E., Land, S., Li, M., Nardin, W., Sommerfield, C. K., & Sweet, W. V. (2018). *Sea-level rise: Projections for Maryland* (p. 27). Cambridge, MD: University of Maryland Center for Environmental Science. Source https://www.umces.edu/sites/default/files/Sea-Level%20Rise%20Projections%20for%20Maryland%202018_1.pdf. (Accessed 13 June 2025).
Bogost, I. (2010). *Persuasive games: The expressive power of videogames*. MIT Press.
Bogost, I. (2021). Persuasive games, a decade later. In Hera, T. Dela, J. Jansz, J. Raessens, & B. Schouten (Eds.), *Persuasive gaming in context* (pp. 29–39). Amsterdam: Amsterdam University Press.
Brown, L. T. (2021). *The black butterfly: The harmful politics of race and space in America*. Baltimore, Maryland: Johns Hopkins University Press.
Bruce, D. G., Cornwell, J. C., Harris, L., Ihde, T. F., Lisa, M., Knoche, S., Lipcius, R. N., McCulloch-Prosser, D. N., McInnch, S. P., Ogburn, M. B., & Seitz, R. D. (2021). A synopsis of research on the ecosystem services provided by large-scale oyster restoration in the Chesapeake Bay. *NOAA Technical Memorandum NOS OMA, 8*, 52.
Brush, L. (2022). *The climate resilience-economy nexus: Advancing common goals*. Washington, D.C: Center for Climate and Energy Solutions. Source: https://www.cakex.org/sites/default/files/documents/the-climate-resilience-economy-nexus-advancing-common-goal.pdf. (Accessed 23 February 2025).
City of Baltimore. (2019). 2019 Baltimore sustainability plan. Source https://www.baltimoresustainability.org/wp-content/uploads/2021/04/SustainabilityPlan_03-02-20-Compressed.pdf. (Accessed 23 February 2025).
City of Baltimore. (2024). Baltimore city's digital inclusion strategy: 2024-2029. Source https://technology.baltimorecity.gov/sites/default/files/Baltimore%20City_Digital%20Inclusion%20Strategy.pdf. (Accessed 23 February 2025).
City of Baltimore. (2025). Baltimore office of sustainability - Baltimore and climate change. Source https://www.baltimoresustainability.org/baltimore-climate-change/. (Accessed 28 February 2025).
Daoliang, L. I., & Chang, L. I. U. (2020). Recent advances and future outlook for artificial intelligence in aquaculture. *Smart agriculture, 2*(3), 1.
Fee, E., Shopes, L., & Zeidman, L. (Eds.). (1993). *The Baltimore book: New views of local history* (Reprint edition). Philadelphia: Temple University Press.
Garland, M., Axon, S., Graziano, M., Morrissey, J., & Heidkamp, C. P. (2019). The blue economy: Identifying geographic concepts and sensitivities. *Geography Compass, 13*(7), Article e12445.
Glotzer, P. (2020). *How the suburbs were segregated: Developers and the business of exclusionary housing, 1890–1960*. New York City: Columbia University Press.
Greene, D. (2021). *The promise of access: Technology, inequality, and the political economy of hope*. Cambridge, MA: The MIT Press.
Guma, P. K. (2025). Transforming the smart city ideal from the margins: Everyday regimes of labour and governance. *Territory, Politics, Governance*, 1–17.
Guma, P. K., & Wiig, A. (2022). Smartness beyond the network: Water ATMs and disruptions from below in mathare valley, Nairobi. *Journal of Urban Technology, 29*(4), 41–61.
Horrigan, J. B. (2020). Baltimore's digital divide: Gaps in internet connectivity and the impact on low-income city residents. *The Abell Report, 33*(4). Baltimore: Abell Foundation.
Hotaling, L. (2021). Chapter 20 - Preparing the workforce for the new blue economy. In L. Hotaling, & R. W. Spinrad (Eds.), *Preparing a workforce for the new blue economy* (pp. 387–405). Cambridge, MA: Elsevier. Source https://www.sciencedirect.com/science/article/pii/B9780128214312000159. (Accessed 23 February 2025).
IMET (The Institute of Marine & Environmental Technology. (No date). IMET strategic plan 2017-2022. Source: https://imet.usmd.edu/sites/default/files/2017%20IMET%20Strat%20Plan_FINAL_high%20res_0.pdf Accessed 27 February 2025.
Iyer, S. D. (2015). Barriers to data sharing for inclusive knowledge management: Why watershedstat in the city of Baltimore failed. In *Innovation in the public and nonprofit sectors* (pp. 91–109). London: Routledge.
Jordan, K. (2024). Rebuild the key bridge with local union labor. *The Baltimore Sun*. Source https://www.baltimoresun.com/2024/04/08/rebuild-the-key-bridge-with-local-union-labor-guest-commentary/. (Accessed 27 February 2025).
Liebel, T. (2006). *Industrial Baltimore*. Arcadia Publishing Library Editions.
Lopez, L. (2024). Rebuilding bridge should not be a union-only project. *Baltimore Sun*. April 20. Source https://digitaledition.baltimoresun.com/tribune/article_popover.aspx?guid=828f98a4-329e-4e26-9f98-c62d6a4b483c. (Accessed 27 February 2025).
Lung-Amam, W., Bierbaum, A. H., Parks, S., Knaap, G. J., Sunderman, G., & Stamm, L. (2021). Toward engaged, equitable, and smart communities: Lessons from west Baltimore. *Housing Policy Debate, 31*(1), 93–111.
Maryland Chamber of Commerce. (2024). Understanding the impact of the key bridge collapse, march 28, 2024. https://www.mdchamber.org/2024/03/28/understanding-key-bridge-collapse-impact/. (Accessed 28 February 2025).
Masucci, M., Organ, D., & Wiig, A. (2016). Libraries at the crossroads of the digital content divide: Pathways for information continuity in a youth-led geospatial technology program. *Journal of Map & Geography Libraries, 12*(3), 295–317.
Masucci, M., Pearsall, H., & Wiig, A. (2020). The smart city conundrum for social justice: Youth perspectives on digital technologies and urban transformations. *Annals of the Association of American Geographers, 110*(2), 476–484.
Mayor's Office of Employment Development. (2023). YouthWorks summer jobs. *City of Baltimore*. Source https://moed.baltimorecity.gov/youth-services/summer-jobs. (Accessed 27 February 2025).
Miller, B., Ward, K., Burns, R., Fast, V., & Levenda, A. (2021). Worlding and provincialising smart cities: From individual case studies to a global comparative research agenda. *Urban Studies, 58*(3), 655–673.
Mitchell, D., Blanche, J., Harper, S., Lim, T., Gupta, R., Zaki, O., Tang, W., Robu, V., Watson, S., & Flynn, D. (2022). A review: Challenges and opportunities for artificial intelligence and robotics in the offshore wind sector. *Energy and AI, 8*, Article 100146.
Najjar, R. G., Pyke, C. R., Adams, M. B., Breitburg, D., Hershner, C., Kemp, M., & Wood, R. (2010). Potential climate-change impacts on the Chesapeake Bay. *Estuarine, Coastal and Shelf Science, 86*(1), 1–20.
National Academies of Sciences, Medicine, Global Affairs, Board on Higher Education, Committee on Improving Higher Education's Responsiveness to STEM Workforce Needs, Identifying Analytical Tools, & Regional Best Practices. (2016). *Promising practices for strengthening the regional STEM workforce development ecosystem*. Washington D.C.: National Academies Press.
National Transportation Safety Board (NTSB). (2024). Contact of containership dali with the francis scott key bridge and subsequent bridge collapse. *May 14, 2024 marine investigation preliminary report*. https://www.ntsb.gov/investigations/Documents/DCA24MM031_PreliminaryReport%203.pdf. (Accessed 28 February 2025).
NOAA (National Oceanic and Atmospheric Administration). (2021). Blue economy strategic plan. Source https://cdn.oceanservice.noaa.gov/oceanserviceprod/economy/Blue-Economy%20Strategic-Plan.pdf. (Accessed 27 February 2025).
Oyster Recovery Partnership. (2025). Oyster restoration. *Source*. https://www.oysterrecovery.org/our-work/oyster-restoration. (Accessed 27 February 2025).
Park, S., & Vitak, J. (2024). Who gets left behind in the push for smart cities? Insights from marginalized communities. In *International conference on information* (pp. 90–104). Cham: Springer Nature Switzerland.
Parsons, E. S., Jowell, A., Veidis, E., Barry, M., & Israni, S. T. (2024). Climate change and inequality. *Pediatric Research*. https://doi.org/10.1038/s41390-024-03153-z
Pietila, A. (2010). *Not in my neighborhood: How bigotry shaped a great American city*. Chicago: Ivan R. Dee.
Rydzewski, P. (2025). Digital inequality and sustainable development. *Problemy Ekorozwoju, 20*(1), 96–108.
Schapiro, R., & Schuppe, J. (2024). *A rare mayday preceded Baltimore bridge collapse: 'I couldn't think of a worse situation.'*. NBC News. March 26, 2024 https://www.nbcnews.com/news/us-news/rare-mayday-preceded-baltimore-bridge-collapse-could nt-think-worse-sit-rcna145212. (Accessed 28 February 2025).
Sharma, D., & Kumar, R. (2021). Smart aquaculture: Integration of sensors, biosensors, and artificial intelligence. In *Biosensors in agriculture: Recent trends and future perspectives* (pp. 455–464). Cham: Springer International Publishing.
Shelton, T., Zook, M., & Wiig, A. (2015). The 'actually existing smart city'. *Cambridge Journal of Regions, Economy and Society, 8*(1), 13–25.
TAFE Directors Australia. (2020). Critical role of blue tech and digital skills in australia's economic recovery. Source https://tda.edu.au/wp-content/uploads/2020/08/Critical-Role-of-Blue-Tech-and-Digital-Skills-in-Australias-Economic-Recovery-August-2020.pdf. (Accessed 23 February 2025).
The Ocean Foundation. (2023). Blue tech clusters of America. Source https://storymaps.arcgis.com/stories/3c3e46acf92f4f39bc42ca2b8307ae99. (Accessed 23 February 2025).
Uz, S. S., Ames, T. J., Memarsadeghi, N., McDonnell, S. M., Blough, N. V., Mehta, A. V., & McKay, J. R. (2020). Supporting aquaculture in the Chesapeake Bay using artificial intelligence to detect poor water quality with remote sensing. In *IGARSS 2020-2020 IEEE international geoscience and remote sensing symposium* (pp. 3629–3632).
Watters, J., & Diezmann, C. (2013). Community partnerships for fostering student interest and engagement in STEM. *Journal of STEM Education, 14*(2), 47–55.
Wiig, A. (2016). The empty rhetoric of the smart city: From digital inclusion to economic promotion in Philadelphia. *Urban Geography, 37*(4), 535–553.
Wiig, A., & Masucci, M. (2020). Digital infrastructures, services, and spaces: The geography of platform urbanism. In *Urban platforms and the future* (pp. 70–84). *City* London: Routledge.
Wood, P., & Zawodny, D. (2024). Key bridge rebuild will be funded entirely by the feds, lawmakers announce. Baltimore Banner. 17 December. Source https://www.thebaltimorebanner.com/politics-power/state-government/key-bridge-full-funding-PZ2K523VEVBARAHEJGMNWK25YA/. (Accessed 27 February 2025).
Zukin, S. (2020). *The innovation complex: Cities, tech, and the new economy*. Oxford: Oxford University Press.