Envisioning a Smart Peoria: Leading the Way with Innovative New Technology

A Fall 2019
Collaborative Project with
Arizona State University's
Project Cities & the
City of Peoria

ASU
Sustainable Cities Network
Arizona State University

Project Cities

PEORIA ARIZONA

This report represents original work prepared for the City of Peoria by students participating in courses aligned with Arizona State University's Project Cities program. Findings, information, and recommendations are those of students and are not necessarily of Arizona State University. Student reports are not peer reviewed for statistical or computational accuracy, or comprehensively fact-checked, in the same fashion as academic journal articles. Project partners should use care when using student reports as justification for future actions. Text and images contained in this report may not be used without permission from Project Cities.

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ACKNOWLEDGMENTS

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On behalf of the Julie Ann Wrigley Global Futures Laboratory, the Global Institute of Sustainability and Innovation, and the School of Sustainability, we extend a heartfelt thank you to the City of Peoria for enthusiastically engaging with students and faculty throughout the semester. These projects provide valuable real-world experience for our students and we hope that their perspectives shine light on opportunities to continuously improve Peoria's future livelihood and community well-being.

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To access the original student reports, additional materials, and resources, visit:
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ABOUT PROJECT CITIES

The ASU Project Cities program uses an innovative, new approach to traditional university-community partnerships. Through a curated relationship over the course of an academic year, selected Community Partners work with Project Cities faculty and students to co-create strategies for better environmental, economic, and social balance in the places we call home. Students from multiple disciplines research difficult challenges chosen by the city and propose innovative sustainable solutions in consultation with city staff. This is a win-win partnership, which also allows students to reinforce classroom learning and practice professional skills in a real-world client-based project. Project Cities is a member of Educational Partnerships for Innovation in Communities Network (EPIC-N), a growing coalition of more than 35 educational institutions partnering with local government agencies across the United States and around the world.

ABOUT SUSTAINABLE CITIES NETWORK

Project Cities is a program of ASU's Sustainable Cities Network. This network was founded in 2008 to support communities in sharing knowledge and coordinating efforts to understand and solve sustainability problems. It is designed to foster partnerships, identify best practices, provide training and information, and connect ASU's research to front-line challenges facing local communities. Network members come from Arizona cities, towns, counties, and Native American communities, and cover a broad range of professional disciplines. Together, these members work to create a more sustainable region and state. In 2012, the network was awarded the Pacific Southwest Region's 2012 Green Government Award by the U.S. EPA for its efforts. For more information, visit *sustainablecities.asu.edu.*

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ASU Sustainable Cities Network
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Sustainability Through Local Action

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ABOUT PEORIA

Ranked as the No. 1 place to live in Arizona by Money Magazine and the only Arizona city named as one of the best cities in the U.S. by Yahoo! Finance, the City of Peoria is currently home to more than 171,000 residents. The City enjoys a reputation as a family-oriented, active community with an exceptional quality of life. Peoria entertainment and recreational amenities include popular attractions such as Lake Pleasant, a large network of trails and open space, community parks, recreation centers, community theater, libraries, pools, and the spring training home for the San Diego Padres and the Seattle Mariners.

The City has demonstrated a strong commitment to sustainability, as evidenced by its directive to incorporate LEED building design standards, a council-adopted Sustainability Action Plan, and a dedicated full-time staff person to manage and coordinate organization-wide sustainability initiatives.

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Peoria is the place
World class ▪ Sustainable ▪ Future Ready

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June 4, 2020

Dear Peoria community members,

It is with tremendous gratitude and excitement that we bring to your attention the results of the first year of our partnership with ASU's Project Cities program. This collaboration provided the opportunity to move beyond traditional resources, and explore all that is possible by working alongside faculty and students across several academic programs.

Project Cities is one of several partnerships we enjoy with ASU, and part of our ongoing strategy to learn from innovative community leaders as we address the complex challenges and opportunities we face as a fast-growing community. With a modest investment in this program, we received extensive research, creative recommendations, diverse perspectives, and innovative deliverables that take several key initiatives to the next level for us.

These include our efforts around water conservation, transit, placemaking, smart cities, and the possibilities around our Skunk Creek corridor near the P83 Entertainment District. Many of these efforts entailed public participation, and you may have participated by speaking to students at one of several Peoria events they attended, or by sharing your personal insight through a survey. By engaging students and faculty on these subjects, we have advanced our understanding and positions on each topic much more quickly than we could have without their assistance.

The project results provided us with invaluable insights into many of our most important opportunities and we are proud to see the students' deliverables advancing. We hold our partnership with ASU and Project Cities in high esteem and look forward to continuing this work on additional projects in the coming year.

Sincerely,

Cathy Carlat, Mayor

Jeff Tyne, City Manager

Peoria, Arizona

Proud partner of

ASU Sustainable Cities Network
Arizona State University

Project Cities

Rio Vista Recreation Center

Demographics

total population: **172,259**

median age: **39.5**

highly skilled and educated workforce of 85,252

11,997 veterans live in Peoria

73% of residents are homeowners

median property value: **$230,400**

31% of residents hold a Bachelor's degree or higher

median household income: **$73,039**

Schools

#3 of 131 Best School Districts for Athletes in Arizona

#5 of 40 Best School Districts in Phoenix Metro Area

#7 of 130 Best School Districts in Arizona

The Peoria Unified School District is one of the largest employers in the West Valley. The district consistently receives high ratings and offers signature programs such as the Career and Technical Education programs.

Peoria is also home to Huntington University, a liberal arts college offering digital media education in animation, broadcasting, film, graphic design and other digital media arts.

Leading industries

Peoria, Arizona is not just a scenic suburb of Phoenix, but also a thriving economic development hub with an educated workforce and high-end residential living. There are 22,470 employers and more than 75,000 people employed within Peoria. Leading industries include health care and social assistance, retail trade, and finance and insurance. Highest-paying industries include utilities, manufacturing and public administration. Beyond these industries, Peoria works actively to attract businesses from aerospace and defense, film and digital media, technology and innovation, hospitality and tourism, and research and development. Peoria is the place for business owners, developers and investors.

Health Care & Social Work
10,905 employees

Retail Trade
10,628 employees

Finance & Insurance
6,574 employees

History

Founded in 1886 by Midwestern settlers, Peoria is nestled in the Salt River Valley and extends North into the foothills around Lake Pleasant. Beginning as a small agricultural town, the economy received a major boost when a railroad spur line was built along Grand Avenue. The construction of the Roosevelt Dam in 1910 secured a reliable water supply, attracting more settlers to the area and business endeavors to the town center. Peoria's economy continued to have an agricultural focus for decades. Continually growing, Peoria assumed city status in 1971 with a population of 4,792. It has since grown into a city with a population over 172,000, and is renowned for its high quality of life and recreational amenities.

Sustainability

Peoria has demonstrated leadership in municipal sustainability efforts through a wide range of actions. Listed below are some of the City's sustainability accomplishments.

- Incorporation of LEED building design standards
- Appointment of a full-time city staff member who manages and coordinates sustainability initiatives
- Sustainable urban planning practices including open space planning and water management principles
- Sustain and Gain: Facebook page and brochures keep residents up to date on city sustainability efforts and ways to get involved
- Water Conservation Program: free public classes, public outreach at city events, and water rebate incentives for residents
- Council-Adopted Sustainability Action Plan: this strategic planning document, in its second iteration, ensures city departments are developing sustainability-oriented goals, tracking success metrics, and encouraging cross-communication in the preparation of Sustainability Update presentations made to the Peoria City Council on an annual basis
- Sustainable University: courses and workshops to empower residents to make small changes that make Peoria a better place to live. Topics covered include residential solar, gardening, composting and recycling

Awards and recognition

- Received three Crescordia awards by Arizona Forward at the annual Environmental Excellence Awards in 2016
- 12th City for Green Space in the U.S. in 2019 *(Wallethub)*
- Top 15 Safest Cities in the U.S. 2017-2019 *(Wallethub)*
- 6th Wealthiest ZIP Code in 2020 *(Phoenix Business Journal)*
- Top 50 Hottest Hoods in 2018 *(Phoenix Business Journal)*
- 10th Best City to Raise a Family in 2018 *(Wallethub)*
- Top 100 Golf Course in U.S. 2017-2019 *(Golf Digest)*

Lake Pleasant

1886 — Peoria founded by William J. Murphy

1889 — First school district formed

1919 — Chamber of Commerce organized

1954 — Peoria incorporated

1971 — Assumed city status with a population of 4,792

1977 — Brewers spring training begins at Greenway Sports Complex

1986 — Centennial celebration

1994 — Peoria Sports Complex opened

2007 — Theater for the Performing Arts and Rio Vista Recreation Center opened

2012 — 20-year extension spring training agreement with San Diego Padres and Seattle Mariners

2017 — Selected as site of new $70M health clinic for Maricopa County Integrated Health System

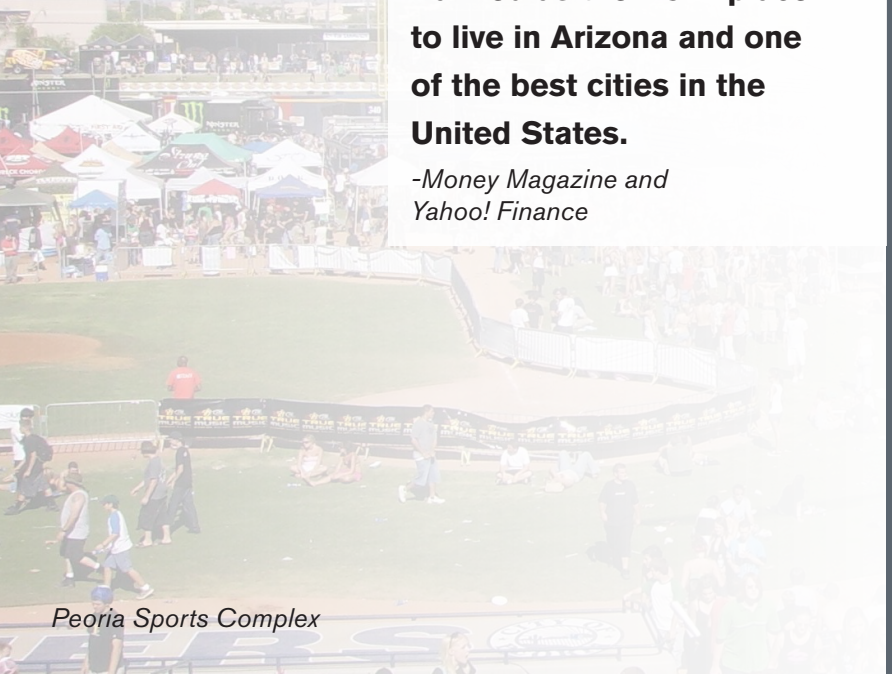
2020

Livability

Peoria is renowned as a great place to raise a family and start a career. A plethora of local amenities and attractions contribute to Peoria's livability. Beyond the tourist attractions of Spring Training and Lake Pleasant, the City offers many community facilities and recreational opportunities for all ages and interests such as an extensive public park system and annual community events. Peoria's dedication toward livability is also evident in the City's latest General Plan which addresses sustainable water use, housing, public services and more.

Ranked as the No. 1 place to live in Arizona and one of the best cities in the United States.

-Money Magazine and Yahoo! Finance



Peoria Sports Complex

Peoria strives to uphold these six major livability priorities in order to maintain an exceptional quality of life for its citizens.

- Arts, Cultural and Recreational Enrichment
- Economic Prosperity
- Smart Growth
- Superior Public Services
- Healthy Neighborhoods
- Integrated Transportation

Community facilities

- Peoria Community Center
- Rio Vista Recreation Center
- Peoria Sports Complex
- Peoria Center for the Performing Arts
- 36 neighborhood parks
- 2 libraries
- 3 swimming pools
- 6 golf courses
- 9 lighted multi-purpose ball fields
- 15 tennis courts

Lake Pleasant

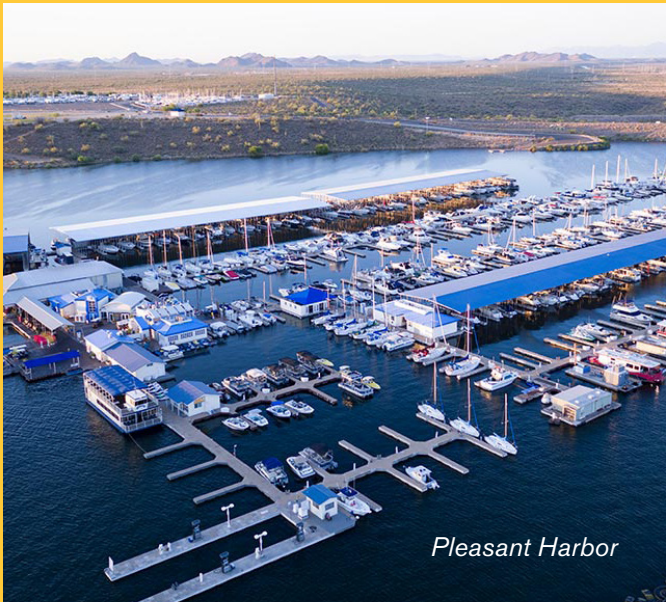
Urban ecology, ecotourism and recreation

Peoria is surrounded by the natural beauty of the Sonoran Desert and is home to Lake Pleasant, a 23,000-acre park and major recreational asset to the North Valley. The transient Agua Fria River and New River flow through Peoria, as do a multitude of washes and creeks. Most notable perhaps is Skunk Creek — known for the recreational trails running alongside it — which forges a connection between Peoria and Glendale. Northern Peoria is home to beautiful mountains and buttes including Sunrise Mountain, Calderwood Butte and Cholla Mountain.

Boasting over 300 days of sunshine annually, Peoria's ecotourism opportunities are a steady industry for residents and visitors. The City features over 60 miles of trails for walking, biking and horseback riding, as well as 570 total acres of accessible park land.

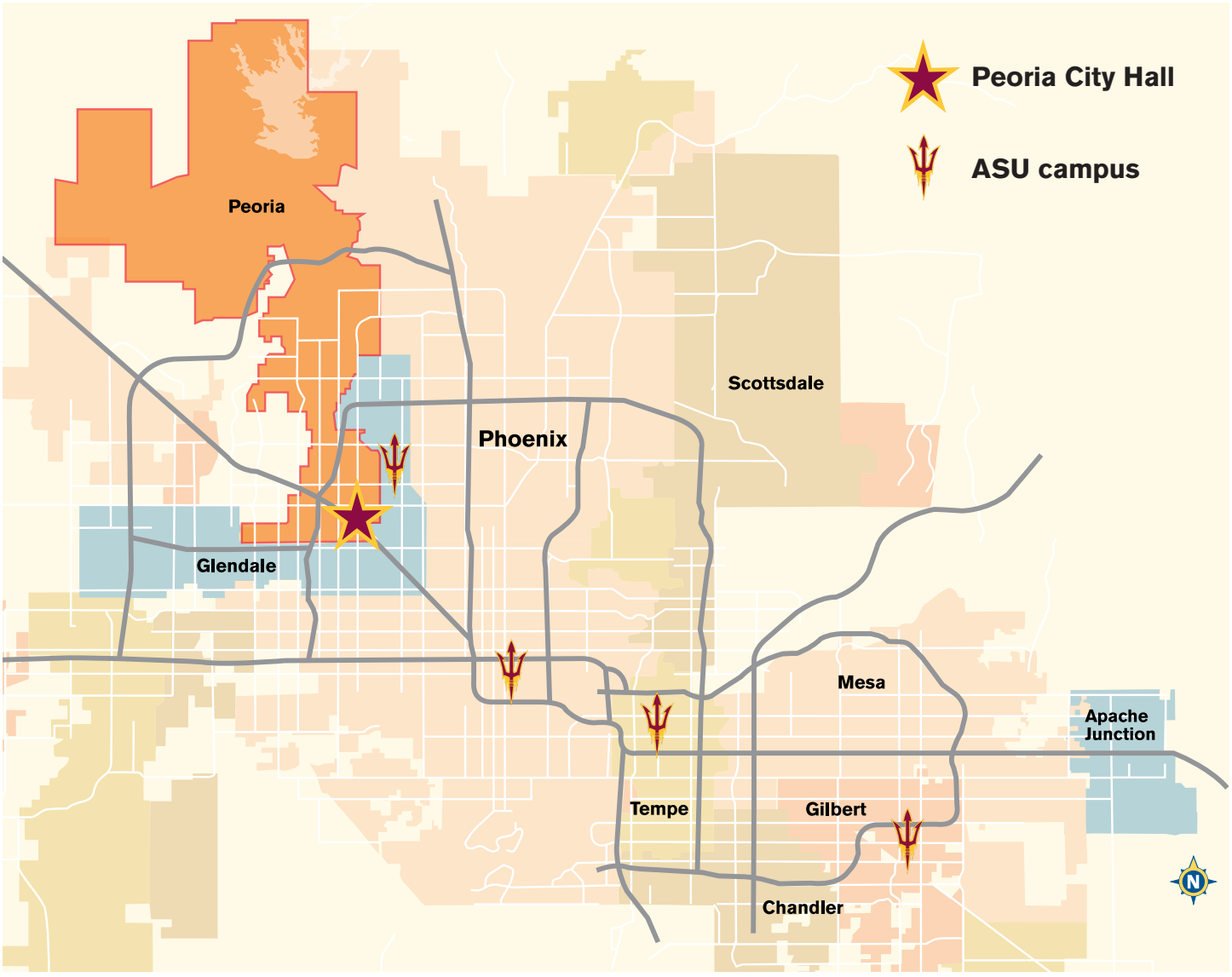
Lake Pleasant Regional Park contains a full-service marina, providing opportunities for water-oriented recreation such as kayaking, water skiing and even scuba diving. Visitors can also go horseback riding, take gliding lessons, hike, camp and more.

Skunk Creek



Pleasant Harbor

MAP OF PEORIA & GREATER PHOENIX, ARIZONA



The following report summarizes and draws highlights from work and research conducted by students in BUS 593/SEC 598 Interdisciplinary Applied Learning Lab, and SOS 498/594 Urban Sustainability Best Practices, for the Fall 2019 partnership between ASU's Project Cities and the City of Peoria.

To access the original student reports, additional materials, and resources, visit:

links.asu.edu/PCPeoriaSmartCities19F

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Sustainability through local action

EXECUTIVE SUMMARY

Smart city technologies comprise innovative advancements embedded in the urban fabric that are designed to improve citizens' quality of life and increase connectivity across communities, both in a city's current state and as it evolves into the future. Through safety enhancement, public space renovation, services improvement, and so on, the potential role of new technology and data collection in cities and towns is practically limitless. A steadily growing community in the Phoenix Metropolitan area, Peoria's interest to invest in a smart city framework is emblematic of the City's commitment to serving its residents and visitors effectively and efficiently.

The potential applications and implementation strategies of smart technologies and infrastructure are numerous. Additionally, by fulfilling community needs and enhancing services, smart technologies can impact a community's economic and environmental sustainability, as well as happiness and well-being. The rollout and implementation of new technology needs to be informed by community preferences and attitudes, as residents may have varying levels of comfort with regards to privacy and other considerations. Smart technologies are also not static, as technology is constantly evolving; thus a city's framework for technology implementation should reflect that reality by being adaptable and responsive to new data, and also proactive in its implementation initiatives.

To help narrow the scope and maximize their research impact, students focused on a few key groupings of smart city technologies, which they determined to have a high community value and perceived impact. The teams studied technology in the role of public safety, including police and fire department applications, and enhancement of the public sphere, specifically parks, trails, libraries, and iconic spaces in Peoria. Students collected data from government resources, academic literature, interviews with Peoria staff and subject matter experts, product research, and a survey of residents. The students' recommendations focused on technologies that would be useful, feasible, scalable, sustainable, and easy to implement. Students suggest that Peoria should aim to consider any future technology integration as part of a broader, planned framework approach, targeted on partnerships, public policy, inter-agency connectivity, and infrastructure.

Collaborative project: Students from two classes, **SOS 498/594: Urban Sustainability Best Practices Application** and **BUS 593/ SEC 598: Applied Interdisciplinary Learning Lab**, collaborated on this project, but still emphasized different elements of Peoria's vision of a Smart City. The business students approached it with a more business perspective whereas the sustainability students took a broader approach utilizing the principles of sustainability. Throughout the process, students engaged with partners from Peoria to tackle the city's challenges, integrating ideas and approaches of the two classes, and synthesizing their work into a cohesive set of final products. As a result of their coordination, final findings between teams were relatively similar. Given this similarity between the final student work, the following summary is primarily built from the SOS 498/594 final report, with additional findings from BUS 593/SEC 598 class, highlighted as excerpts throughout.

The findings outlined in the following class summary aims to provide the City of Peoria a planning framework to leverage and enhance its smart city technologies, and subsequently benefit its residents, city employees, and visitors alike. The findings and recommendations contained in this report should not be considered a comprehensive study, and instead be viewed as an introductory foundation to broaden and leverage Peoria's usage of technology in its vision toward becoming a Smart City.

Figure 1 *Students collaborated across classes throughout the semester, before coming together to present findings at the Fall 2019 End-of-semester Showcase event*

GOALS & RECOMMENDATIONS

The student research first sought to develop a clear definition of Smart Cities for Peoria to utilize within their planning framework. Both classes used this definition as their reference point. Subsequently, on advisement of Peoria, the work centered on in-depth analyses of three municipal service areas: public safety, public spaces, and public amenities. These focus areas formed the basis for the set of recommended strategies and specific, novel technologies that can potentially be part of the implementation of smart city technology for Peoria. The following recommended actions are drawn from that research and are intended to be feasible, scalable, and sustainable, and in line with the students' assessment of Peoria's current needs and circumstances

Figure 2 *Peoria Real Estate Development Officer Scott Whyte presents to students at the Fall 2019 Kickoff event*

Figure 3 *BUS 593/SEC 598 students share their key findings to Peoria city leadership at the Fall 2019 End-of-semester Showcase event*

RECOMMENDATIONS TO BUILD A SMART PEORIA

General strategic recommendations
Leverage public-private partnerships and engage with the community when making decisions on acquiring new technology that may feature privacy concerns (pp.32, 39).
Partner with startups or other businesses (especially local) to continue building a network with the potential to provide cutting edge technology in the future (pp.32, 38-39, 59).
Test new technologies before fully equipping the department to avoid “new technology” prices and leave existing systems intact if the new technology is deemed inadequate (pp.38-39).
Evaluate new technologies based on its universality and versatility. New technologies should be interoperable with other technologies and able to be reconfigured to meet changing needs (pp.39, 43, 45).
Seek out Smart Growth grants to assist with Peoria's anticipated growth to the North, as it is an opportunity to plan and build infrastructure on a clean slate (pp.38-39).
Determine the legal framework under which smart technologies can be implemented. Address privacy concerns, implementation strategies, and changes to the municipal code to allow decision makers to better understand their constraints (p.46).

RECOMMENDATIONS FOR PUBLIC SAFETY

Fire Department recommendations

Invest in technology that increases interoperability, interconnectivity, configurability, and GIS applications. Explore these technology characteristics on a county-wide scale and attempt to coordinate with other West Valley cities (pp.35, 38-39).

Participate in university research surrounding fire hazards of green buildings and mixed-use communities and begin collecting additional data during fire code inspections (pp.36, 38-39).

Analyze data to best position any future fire stations. Additionally, future stations could be built to LEED certification standards to lower maintenance and operation costs (p.39).

Consider data-sharing agreements or custom software patches as opportunities that allow for more seamless data transfers of report details, or coordinating with the Police Department by utilizing the same computer-aided dispatch system (pp.36, 38, 40).

Coordinate with nearby cities on the implementation of FirstNet to eliminate redundancies and expedite data sharing (pp.34, 40).

Police Department recommendations

Increase connectivity of existing assets to help integrate communication resources across Peoria. For example, identify gaps and install repeater stations where there is a lack of direct line of site communication (pp.42, 45-46).

Create a social media strategy that recognizes the multitude of platforms to better embed the police force with the next generation of citizens (pp.42, 44-46).

Establish an information technology (IT) committee to evaluate which technologies merit further study and which ones should be purchased immediately (pp.43, 45-46).

RECOMMENDATIONS FOR ICONIC SPACES

Peoria Sports Complex recommendations
Optimize water efficiency by using water management technology such as soil moisture sensors and water meter analytics (pp.47, 50-51).
Replace some grassy areas with artificial turf or desert landscaping (where appropriate), to save water, have more drought-resilient fields, and reduce maintenance needs (pp.50-51).
Lower energy needs by further implementing Schneider Electric Energy Management System for HVAC and lighting control throughout the stadium (pp.50-51).
Invest in state-of-the-art visitor engagement technologies such as Wi-Fi and an engaging mobile app for game day features, communication and convenience (pp.49-51).
Consider implementing high-tech camera equipment for motion analytics, which could benefit the fans for entertainment as much as the teams, for player evaluation and training (pp.49-51).

RECOMMENDATIONS FOR ICONIC SPACES (CONT'D)

Peoria Center for the Performing Arts (PCPA) recommendations

Install motion-activated lighting to better navigate spaces. Dimmable lighting is recommended so as not to interfere with shows and theater lighting (pp.54-55).

Invest in a smart screen touch display and an additional movable screen to be used in meetings, for groups renting studio spaces, and as interactive tools in the lobby space (pp.52-55).

Install an acoustic control system in the lobby with acoustic ceiling panels and smart speakers, to enhance the audial experience of visitors, and allow the space to suit a wider variety of uses (pp. 52-53, 55).

Update the Center's outdoor sign to an LED display screen to provide higher visibility and engagement (pp.54-55).

Provide Wi-Fi both within the building and throughout Osuna Park to engage patrons and the community during events (pp.53-55).

Utilize augmented reality and Virtual Reality (VR) technologies during some performances to attract patrons to the theater and save on set-building costs (pp.52, 55).

Improve the existing projection technology, potentially with multiple projectors, to enhance the visual engagement of the audience and overall experience of the theater (pp.52-55).

Use lighting design technology, such as laser projection lighting, in Osuna Park to support performances or events in an entertaining way (pp.54-55).

Improve general park lighting by layering the lighting levels to assist with wayfinding and extend the hours of park usage (pp. 53, 55).

Install sound systems to support programming and events in the park, and potentially increase the types of performances that can be hosted in the park (pp. 53, 55).

P83 recommendations

Introduce technologies throughout the district that improve the quality of public space, such as public Wi-Fi, misters, waste bin sensors, HAWK (High-Intensity Activated CrossWalK Beacon) signals, security measures, traffic cameras, and lighting features (pp. 56, 58-60).

Facilitate use of P83 as a public space by improving existing mobile applications, such as Peoria on the Go (POGO) and the Peoria Reporter app (pp.59-60).

Invest in marketing and social media campaigns for public spaces throughout Peoria, including P83, to spark public interest (pp.59-60).

RECOMMENDATIONS FOR PUBLIC AMENITIES

Public outdoor trails recommendations

Develop an application for local trails that allows information to pass between users and the City, bridging the gap between trail users, active conditions, and city services (pp.63, 65-67).

Provide location-specific digital displays on trails that can teach users about the surrounding area as well as connect users to nearby alerts or updates (pp. 63, 67).

Update interactive trail maps on Peoria's website to be more user-friendly and informative. Include displays for data collected by trail sensors, such as traffic and temperatures (pp.66-67).

Utilize QR codes on trail signage to increase engagement and give users information on locations and features (p.67).

Develop a bike-share program to increase trail use and connectivity while providing an alternative mode of transportation (p.67).

Mitigate health risks by using sensors to record and report ambient temperatures, air quality, and other environmental hazards. Collected data can be shared via mobile applications, websites, and digital sign kiosks (pp.63, 65-67).

Install small cell technology on existing trail infrastructure to improve wireless signal strength and accommodate widespread implementation of the internet of things (IoT) (pp.63, 66, 68).

Install solar path lights along trails to provide energy-efficient lighting and increase user comfort and safety in the evening hours (pp. 65, 68).

Public park recommendations

Use existing infrastructure to implement new technologies, such as retrofitting sensors to security cameras and affixing smart devices to existing shade structures (pp.69, 71, 73-74).

Incorporate surveillance cameras in parking lots for safety, and in high-use sports fields to potentially record games (pp.73-74).

Incorporate Musko lighting in fields and parking lots for energy efficiency and safety (pp.69, 73-74).

Partner with local vendors for concession areas to promote community building and encourage healthy food options (pp.69, 73-74).

Install solar shade structures in high-use areas, such as near sports fields to provide charging stations to park users (pp.69, 71, 73-74).

Replace or retrofit existing standard play structures with interactive play structures that can be internet connected and programmed to feature various games (pp.69, 73-74).

Consider installing new technologies such as solar trees, luminescent paint, smart furniture, or energy harvesting tiles as they become available (pp.70, 72, 74).

RECOMMENDATIONS FOR PUBLIC AMENITIES (CONT'D)

Library recommendations
Utilize the online scheduling platform to allow people to search and sign up for library events. It may also be beneficial if patrons can use the website to check out Explore-To-Go kits and Culture Passes (pp 80, 83).
Develop a “teen space” with different gaming consoles and high-speed computers to foster engagement with the teen community (pp.80, 82-83).
Provide movable furniture to allow patrons the freedom to create custom workspaces. Adding more group spaces and accessible charging stations may also improve the workspace experience (pp.79, 83).
Implement assistive technologies for visual materials such as screen-reading and magnification technology through closed-circuit television (CCTV), Braille translation software, and portable magnification devices for books. Web services like ZoomText and Job Access With Speech (JAWS) are also common accessibility tools (pp.75, 82, 84).
Implement assistive technologies for audio materials such as listening devices, automatic captioning features, and small amplifiers. Hearing loops are also popular for transmitting announcements amidst ambient noise (pp.75, 82, 84).
Conduct additional surveys specifically centered on accessibility and connectivity to determine which specific technologies Peoria residents may find useful (p.84).
Consider installing helpful technologies, such as bulk separators, laptop and tablet kiosks, and interactive multi-touch tables, to enhance library experiences for guests and employees (pp.76, 83).
Upgrade the libraries’ main web platform to Polaris Leap, allowing for automatic updates, a modern interface, and web browser flexibility (pp.76, 83).
Develop a long-term plan to build a smart library of e-books, available to checkout online, to better serve patrons that otherwise may not be capable of physically visiting a library (pp.76, 84).

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IRA A. FULTON SCHOOLS OF ENGINEERING

Envisioning a Smart City: Leading the way with innovative new technology

Visioning and feasibility studies to leverage and enhance technological innovation throughout the City of Peoria

ACKNOWLEDGMENTS

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INTRODUCTION

Excerpted from Beecher et al., pp.1-2

Smart Cities utilize the investment of technology integration in public spaces and infrastructure, with the goal of improving efficiency or connectivity for the betterment of the community. Through technology integration, Smart Cities can enhance quality of life, improve public service efficiency and effectiveness, and strengthen community connections. For smart technology to be useful, it should be reactive to collected data, as well as proactive in its attempt to improve existing conditions. Students determined that if a Smart City is to be successful, its technology integration plans need to be feasible, actionable, implementation-focused, creative, vision-based, and reality-checked.

The City of Peoria, a steadily growing contemporary suburban community, seeks to meet the challenges of improving the quality, availability, and accessibility of public services, while also lowering the associated cost of services to its citizens. To help accomplish these at times conflicting goals, students have conducted an examination of Peoria's ability to become a Smart City, leveraging innovative new technology to position itself as a vibrant economic and residential destination in the West Valley.

This report evaluates three municipal service areas: public safety (police, fire and emergency medical services), public amenities (libraries, parks and trails), and the administration of community spaces (P83, Peoria Sports Complex, and, Peoria Center for the Performing Arts). The process included an inventory of assets, strengths, weaknesses, opportunities, and threats (SWOT) analysis and review of documents and resources provided by the City. The students found an **uneven level of technology integration throughout the City's portfolio.** While the assets are inconsistent, a pervasive theme emerged of city officials and administrators already starting small projects to lead the way toward a greater degree of integrated resource management and data analytics. It is evident that Peoria wants to be a Smart City, and with the right guidance from city leadership and the political will, the City could make that transition relatively quickly.

The inventory and recommendations reviewed in this report are not comprehensive, but are intended to provide an in-depth analysis of primary assets already available, identify where to integrate smart technologies within the city in the future, and what steps should be taken in the short- and long-term to make that transition smoothly.

Problem statement

The City of Peoria, in collaboration with Arizona State University's School of Sustainability (ASU), sought to explore actionable suggestions for the integration of smart technology and infrastructure into the city's urban fabric (for the 2040 General Plan). **Peoria and the West Valley are interested in envisioning a smart city of the future**, which will increasingly use technology to reduce cost, while improving the delivery of public services, thus improving community members' quality of life.

RESEARCH METHODS

Team formation and collaboration

The two classes embarked on this assessment as a multi-disciplinary collaborative project. Early in the semester, students in each class subdivided into teams, each with a different municipal activity or space to investigate. Teams were divided by class, but collaborated closely with one another. Students freely shared ideas and resources over the course of multiple class meetings with the assistance of appointed class ambassadors. The **SOS 498/594** students focused on short-term objectives in their research, identifying recommendations that could be implemented in 1-3 years, while the **BUS 593/SEC 598** class focused on longer-term objectives to be implemented over a course of 3-5 years.

Editor's Note

As the students concluded their work, some reported that a longer time horizon would have been a more meaningful distinction for "long-term" objectives. This experience could help inform the framing of future smart city development efforts.

The teams conducted extensive review of documents including general plans and reports related with the City, interviewed city staff and employees of relevant departments, developed asset maps or inventories of assets, and conducted SWOT (strengths, weaknesses, opportunities, threats) analyses. In their efforts to distill the best suggestions for the City of Peoria, students sought out feasible recommendations that could increase efficiency, citizen satisfaction, productivity, and public safety.

The SOS 498/594 students also developed a Scope of Work (SOW) document as part of their process, to guide their research and final deliverables. These students established a research timeline, determined what services they would provide, outlined Peoria commitments and responsibilities, and detailed the products to be completed by the end of the project. These products included:

- An in-depth inventory of Peoria's Technology Assets
- A detailed SWOT Analysis
- A Smart City Development Readiness Assessment (with Gap Analysis)
- Vision-based recommendations
- A presentation of Peoria and West Valley Smart City asset readiness at the Fall 2019 End-of-Semester Showcase event
- An in-depth report of existing asset readiness with an executive summary (the following final report)

Defining Smart Cities

The students' first challenge was to develop a comprehensive definition of "Smart Cities" that would provide a baseline framework for its use within their research and subsequent deliverables. During a class meeting early in the semester, students and faculty conducted a workshop with city staff to reach a shared definition. During this workshop, it was determined the definition needed to address:

- Innovation
- Scalability/support continual growth
- Accessibility for the public/connect communities
- Improvements to quality of life
- Process improvement of city infrastructure

Students collaboratively developed the following Smart Cities definition to be used throughout the project:

Smart Cities use data and technology to increase connections across and within communities and to improve the quality of life for all citizens now and as the city evolves into the future. A Smart City is a framework, predominantly composed of Information and Communication Technologies (ICT), to develop, deploy and promote sustainable development practices that address growing urbanization challenges.

Figure 4 provides a detailed explanation of the essential aspects reflected in the definition.

Defining Smart Cities	
Innovation	Integration of current technology with future technology Rethinking the purpose and potential of open spaces
Scalability/support continual growth	Regulations/policies Costs reduction Flexibility Efficiency Sustainable
Accessibility for the public/ connect communities	User friendly Bandwidth
Improve quality of life	Green and clean technology Sustainability
Process improvement of city infrastructure	Data collection and analysis for improvement

Figure 4 *Students ensured each "essential aspect" of Smart Cities was encompassed within their definition, from Beecher et al., p.2*

Data collection and analysis

The data was collected from diverse sources including government resources, academic journals, and interviews with key experts. The information gathered from these sources contributed to a benchmark of existing technologies and services that could be helpful to the City of Peoria.

> ***Excerpted from Beecher et al., p.3***
>
> *Government resources, including the Department of Justice, National Criminal Justice Reference Service (NCJRS), and National 911 program under the National Highway Traffic Safety Administration's Office of Emergency Medical Services, were heavily used to investigate public safety applications.*

Interviews

Interviews were held with key city officials and subject matter experts, including Lieutenant Anthony Wolf from the Peoria Police Department, Deputy Fire Chief Gary Bernard, and employees of the Pinnacle Peak Public Safety Facility. The interviews helped to gain an inside perspective on what technologies Peoria's public safety departments currently have at their disposal, and opinions on what changes are most needed.

Figure 5 *Students interview Peoria Police Lieutenant Anthony Wolf and Peoria Deputy Fire Chief Gary Bernard at the Fall 2019 Kickoff event*

Visioning exercise

Students conducted a guided visioning exercise with faculty, using narrative to describe the provision of "smart" services in each of their topic areas. This enabled students to approach their research with an improved framework for understanding the concept, and a reference point for a "realistic" scenario.

Omnibus survey

Seeking insight from Peoria residents as well, students took advantage of an omnibus survey conducted during the Fall 2019 semester. Students from multiple classes, working on a variety of research projects in partnership with the City of Peoria, developed a total of 75 survey questions that helped them further understand resident demographics, values, goals, and community needs. A block randomization tool was utilized to select a random or demographic-contingent group of questions for each respondent, ensuring all classes received input, but no single resident answered all 75 questions.

The survey was designed with demographic and opinion-based questions, including Likert-type items and ranking questions. Approximately 380 respondents answered questions specifically related to smart city technologies. The feedback generated from this large survey helped students guide their research toward the topics and issues that reportedly mattered most to Peoria citizens, and subsequently would be most impactful.

Inventory of assets

Students compiled findings from their research to develop an inventory of existing technological assets, to gain a more complete understanding of Peoria's current status as a Smart City. The inventories were non-exhaustive, as there is no centralized or uniform tracking for the City's smart assets. This information would nonetheless serve as foundational in the students' analyses.

Gap analysis

A Gap analysis was conducted for each category of technology. This analysis identifies the difference between the ideal scenario and current conditions, helping the students to identify prime opportunities for improvement.

SWOT analysis

Following the initial asset inventory process and subsequent gap analysis, students compiled a strengths, weaknesses, opportunities, and threats (SWOT) analysis for each service area including the Police and Fire Departments, libraries, parks, trails, and “iconic spaces” (P83, Peoria Sports Complex, and the Peoria Center for Performing Arts). The SWOT analyses, summarized in the following sections, organize information into concise categories to facilitate a better understanding of context and potential solutions.

Product research

After developing an improved understanding of Peoria’s needs for each topic area, students conducted product research to identify specific, implementable solutions. This analysis allowed for more realistic recommendations, based on existing products and prototypes that employ Smart City principles.

Figure 6 *A student presents the Peoria Fire Department inventory of assets at the Fall 2019 End-of-semester Showcase*

Students reviewed Peoria’s readiness to begin a transition to the Smart City model by establishing an analysis of major assets within city parks, trails, public spaces, libraries, and police and fire services. Based on the analysis, students provide potential focus-areas for pragmatic smart technology strategic planning using vision-based models. This results in a set of feasible and actionable recommendations for Peoria’s next steps in this endeavor.

FINDINGS AND ANALYSIS

Public safety

The City of Peoria explicitly states in its General Plan that the quality of its police and fire services should be "exemplary:"

"A sense of safety and security is often one of the top quality-of-life indicators in a community. The City recognizes that safety concerns have a major impact on the health, economic viability, and quality of life of the community. Peoria is dedicated to creating a safe city for residents and visitors, which is achieved through exemplary fire, emergency medical, and law enforcement services" (Plan Peoria AZ, 2019).

This vision was corroborated in subsequent conversations with Peoria staff, so **the students focused their efforts primarily on smart city technologies that improve the provision of direct services in law enforcement, firefighting, and emergency medical services.** These services are foundational to Peoria's ability to achieve all other goals outlined in the General Plan. This does not mean smart city technology applications in other areas of the departments (i.e. supportive/administrative and cost-reduction strategies) were ignored, they simply were not deemed to be the primary focus of this report.

Excerpted from Beecher et al., pp.4-6

Prioritizing the formation of partnerships across communities is a common trend across cities that are adopting smart technologies. Partnerships with educational and business entities facilitate increased levels of collaboration between organizations, agencies, and cities. Educational partnership (such as Peoria's partnership with ASU Project Cities) can be extremely efficient means of collecting valuable research pertinent to safety services. Studies reveal research partnerships to be largely beneficial in their ability to offer new perspectives and skills, third party credibility, increased capacity and efficiency, and improved community relationships. A partnership example is the Boston Police and Harvard University collaboration with Professor Anthony Braga, who developed the Safe Street Teams which assisted in hot spot policing. These types of partnerships can be internally funded by specific departments, or externally funded through grants.

FIRE AND EMERGENCY MEDICAL SERVICES

The Fire Department can be divided into two main services, firefighting and emergency medical services. It is worth noting that Peoria's most utilized service of the two is medical. This is a trend that is expected to continue, as fire safety standards are always improving, and thus, fires become increasingly less frequent. A complete inventory of technology utilized by Peoria's Fire Department would be extremely long. Therefore, the firefighting and emergency medical services (EMS) technological assets discussed in this report must be regarded as a partial list. The inventory selection process was guided by smart city technologies, concepts, and ideals which were revealed by current research, publications, and individuals with relevant experience.

Visioning exercise: Fire

In the student envisioned ideal scenario, a fire is identified by a sensor and is automatically reported to the central dispatcher, who immediately notifies the nearest firefighting unit while simultaneously initiating a confirmation of the sensor-generated data. If it is a false alarm, the call is canceled. If it is valid, the firefighters are already on their way. En route, firefighters can track data from the signal and access relevant information about the structure and its occupants, which is collected by inspectors and volunteered by the public. Once on the scene, they use that information to quickly gather the most effective gear, and effectively assess the most likely locations for potential rescues. The information is also used to reveal the safest routes throughout the structure. While the crew are inside, a drone circles the building to assist the command in monitoring how the fire is spreading and detecting damage to the structural integrity of the building. All previously acquired information is further supplemented by personal protective equipment (PPE) that senses its own operational status and specific hazardous environments, as well as the firefighters' biological responses. This data can be accessed by individual crew members via an in-mask heads up display (HUD) and by command. Communications are clear and include both crew-to-command and crew-to-crew functionalities. In dense smoke, ultrasonic telemetry technology is used to identify the locations of the crew. Post-call, all relevant data is entered into a centralized database system that can be analyzed to monitor or improve current operations, or successfully develop new practices and procedures.

Excerpted from Beecher et al., pp.8-9

Streamlined emergency communication is necessary for emergency services to function optimally. In response to the tragic events of 9/11, the U.S. government identified substantial gaps in emergency communications, and subsequently recommended the creation of a nationwide network for public safety communications. In 2012 Congress created the First Responder Network Authority, known as FirstNet. The network's authority resides within the Department of Commerce which has the mandate of building, operating, and maintaining the network. As FirstNet grows, it is important for cities to plan for its implementation in their communities by purchasing devices and software that are compatible with the system.

Visioning exercise: EMS

In a situation envisioned with smart city technologies, an EMS call is received at the central dispatch location. The closest unit is immediately identified and alerted. The ambulance utilizes multiple technologies, including geographic information system (GIS) mapping, to get to the scene and transport the patient to the hospital as quickly as possible. Once on the scene, advanced cloud-based mobile communications technology allows the responders to use an electronic patient care record (ePCR) to both record data into a system and send it to the hospital in real time. Additionally, medical devices used on the scene automatically update diagnostic data into the system. If the patient is identified as a "repeat customer," responders have immediate access to all previously collected patient data and do not need to enter as much information into the database. Advanced medical equipment allows the responders to effectively diagnose specific medical conditions and begin proper treatments on the scene. Upon emergency room arrival, medical staff is already prepared to treat the patient's specific medical condition. All relevant data is entered into a database system and analyzed to identify any inaccuracies or performance gaps, and to reveal the possible causes and solutions.

Inventory of assets

Inventory assessments were carried out at both the Peoria Fire Department's administrative location and at Fire Station 191. At these locations, all new technology recommendations are submitted to an IT committee for evaluation and approval. In these evaluations, the risk associated with the adoption of novel technologies (i.e. to what degree is the technology related to safety and to what degree has its dependability been proven) is considered alongside a traditional cost-benefit analysis. The evaluation in and of itself could be considered an asset. Figure 7 details the Peoria Fire Department inventory of assets.

Fire and EMS smart city technology assets include:
A centralized, county-wide database and dispatch system
Cloud-based servers, processors, and software
GIS mapping and data analytics
GPS
Mobile Computer Terminals (MCT's), tablets, and their associated software (e.g. computer-aided dispatch, system display, digital inspections, and electronic patient care reporting)
Drones
Sensors (e.g. steam flow, hazmat, and personal protective equipment)
In-mask communications
Head-up displays (HUDs)
Zoll mobile heart monitors

Figure 7 *Inventory of assets developed by students in consultation with Peoria Fire Department staff*

According to Peoria's Fire-Medical Deputy Chief, the most advanced technology utilized by the Fire Department are its Zoll mobile heart monitor medical devices. At $20,000-$25,000 per unit, they are capable of firmly diagnosing a heart attack on the scene and of providing the necessary treatment.

Gap analysis

Although Peoria's Fire Department operates within a county-wide, centralized system, variations in software use throughout the valley make it difficult to effectively share and utilize data. This means that **while the Peoria Fire Department meets the Smart City criteria of being "integrated," it falls short of being fully "interconnected" and interoperable."**

Fire department data is notoriously underutilized, according to Peoria's management analyst. A prime example is the Smart911 website, which allows residents to enter important information (e.g. medical, occupancy, location) that they may be unable to communicate to 911 dispatchers during an emergency. This life-saving asset is under-promoted and only used in a select few cities (including Peoria) rather than across the valley.

> ***Excerpted from Beecher et al., p.8***
>
> *During interviews with Peoria firefighters, it was reported that a common inefficiency occurs when a neighboring city responds first (due to proximity) to an incident within Peoria boundaries. The transfer of report details from a neighboring city's agency is arduous, and interviewees reported up to 1.5 hours of time spent rewriting these types of reports. Interviewed Peoria police officers reported similar issues. Data-sharing agreements and custom software patches may be opportunities that allow for more seamless data transfers of report details.*

Increased data collection, including 3D imaging (e.g., during fire code inspections), could help firefighters more safely navigate structures. Thermal imaging in a firefighter's HUD would also be useful in this respect. Ultrasonic telemetry can provide this feature, which can also help crewmembers locate each other, in addition to providing biometric data and PPE status updates to command. In-mask communications are currently only crew-to-command but could be expanded to include crew-to-crew communication. Sensors are generally underutilized, and the current use of sensor technology is restricted in terms of its sophistication (e.g., prone to cross-contamination) and its application. The latter may be a result of the former.

Lessons learned from a variety of past incidents suggest that sensors that record temperature, force, and pressure would enhance firefighter safety on future responses. One tool that the Peoria Fire Department has acquired, pending delivery is its first exploratory robot. The robot will be used to enter hazardous environments, sense and record data, and send data and images back to command. The Peoria Fire Department is also in the process of updating its GIS and training software and hardware. However, the software used to track and maintain the department's PPE would benefit from a barcode system that would make stocking/repairing inventory faster and more precise.

Excerpted from Beecher et al., p.10 *With the high amount of recommended data collection, data storage also needs to be considered. In general, Peoria will need data storage for any department or entity that wishes to implement smart technology. Therefore, this recommendation is not limited to Police and Fire, however potential means of data storage were studied specifically with Police and Fire in mind. For first responders, data storage is necessary to improve safety and efficiency, and reduce costs through analytics. However, to analyze the data, it needs to be securely stored, accessed, and kept in unison with new data that is constantly incoming. Students suggest cloud storage to be more cost effective, efficient, and scalable than establishing a new, physical in-house storage facility. Two examples of secure cloud data services include Amazon Web Services and Evidence.com.*

Fire Department SWOT analysis

Strengths

Phoenix as a **centralized data collection** and dispatch center increases efficiency (less storage, faster access, and overall decreased costs) and the usefulness of collected data.

Federal standards can help create universal coding schemes, the foundation for increasing future data use.

Cloud services can increase storage and computing power needed for technological advancement, and reduces costs associated with space, equipment, maintenance, and energy use.

The Fire Department is in the process of upgrading their **GIS** software, which many consider to be the future of data collection and analytics.

The IT Committee ensures all tech recommendations are vetted and often attends technology conventions. This is foundational to maintaining a smart decision-making process in regards to smart technology.

The Fire Department has **mobile technologies** and sophisticated medical devices with the ability to collect and transfer data, which is a growing trend with smart city technologies.

Digital inspections enhance data collection, and thus data usage, while saving time and money.

Weaknesses

Equipment technologies (e.g., Communications, Crew status, and HUD) could be improved. Sensors are underutilized and unreliable, situational awareness options are limited, and drone use is restricted.

Software differences between departments across the county prevent data from being fully utilized.

Opportunities

Expected growth in North Peoria is an opportunity to pursue Smart Growth funding. Research opportunities specific to smart fire services may also be useful.

The centralized, county-wide system that is already in place will make transitioning from integrated to interoperable and interconnected much easier and cost-effective.

Once operational data collection and analytics are improved, they can be used to better **identify county-wide best practices.** Already, cities could be sharing data to make improvements.

Partnering with Project Cities connects the department with students who can help improve services through research. A **partnership with local companies** could produce similar contributions. These arrangements save money, keep risk low, and provide new technology experiences.

Increased **community engagement** in the planning processes could garner public support and mitigate opposition toward new technology.

Current software use is beneficial, but quickly and accurately **tracking and maintaining Personal Protective Equipment** can be enhanced (e.g., through barcoding).

Threats

Cutting edge technology is expensive and constantly changing. Such expenses can be supplemented by grants, however smaller cities are not often awarded them.

Crews work in **hazardous conditions** and rely on technology to keep them safe. High-risk consequences do not allow for utilization of the most cutting edge smart technology. Rather, it must be fully tested.

Privacy concerns may cause public and policy opposition resulting in obstacles to data collection/ utilization, or rendering certain technology applications ineffective.

Federal safety standards restrict the amount of smart city technology that can be considered.

Recommendations

The Fire Department could be categorized as Smart City ready by today's technology standards. However, to keep pace with quickly advancing technology (or to get ahead of the curve), there are some actions the City of Peoria may want to consider.

- Leverage public-private partnerships and engage the community when making decisions on acquiring new technology that may instigate privacy concerns. This can help avoid opposition pitfalls to potentially controversial decisions.
- Partner with startups or other businesses (especially local) to continue building a network of scholars and professionals that can help provide cutting edge technology or expert input. This strategy addresses both budgetary and risk issues.
- Test new technologies before fully equipping the department to avoid paying “new technology” prices and leave existing systems intact for a certain period in case the new technology is deemed inadequate. This procedure provides the benefits of using new technology without the risk of commitment to a technology purchasing contract.
- Evaluate new technologies based on its universality and versatility. New technologies should be interoperable with other technologies and able to be reconfigured to meet changing needs.
- Invest in technology that increases interoperability, interconnectivity, configurability, and GIS applications. Explore these technology characteristics on a county-wide scale and attempt to coordinate with other West Valley cities.
- Seek out Smart Growth grants to assist with Peoria's anticipated growth to the North, as it is an opportunity to plan and build infrastructure on a clean slate.
- Participate in university research surrounding fire hazards of green buildings and mixed-use communities, as they will undoubtedly become part of Peoria’s future growth, and usually pose challenges to traditional firefighting procedures. Better data collection during fire code inspections of these types of buildings should also be prioritized.
- Analyze data to best position any future fire stations. Additionally, future stations could be built to LEED certification standards to lower maintenance and operation costs. This would also serve as a way for the Fire Department to address sustainability, which was identified as the only neglected area of those evaluated in the department’s SWOT analysis.

- *Consider data-sharing agreements or custom software patches as opportunities that allow for more seamless data transfers of report details, or coordinating with the Police Department by utilizing the same computer-aided dispatch system (Beecher et al., p.8).*
- *Coordinate with nearby cities on the implementation of FirstNet to eliminate redundancies and expedite data sharing (Beecher et al., p.9).*

LAW ENFORCEMENT

The Police Department provides the traditional services of crime prevention and investigation of criminal activities. While police utilize many of the traditional tools of law enforcement agencies, this report will deal primarily with electronic assets that help officers collect data for analysis, communicate more effectively, or use artificial intelligence to conduct traditional police work in a faster and more accurate way. Again, this inventory was specifically targeted at those items and therefore can only be regarded as a partial list with a focus on the key assets.

Visioning exercise

Through the visioning exercise, it was determined that a smart police department leverages data in multiple forms to quickly assimilate information and enable quick, informed decisions that protect and serve the citizenry. Callers to a smart 911 center can send photos, video, and text to enable greater remote situation assessments. Those photos and video can be immediately transmitted to the officers being dispatched, allowing additional time for law enforcement to remotely review the issue. If officers must enter a building, aerial drones are available and can be deployed to survey the area around a structure for potential threats and obstructions. Integrated city records can provide quick access to key information like floor plans. In the event of a pursuit, GPS trackers could be deployed on a fleeing vehicle, eliminating the need to enter a high speed and potentially dangerous situation. In a large public gathering, artificial intelligence (AI) can be used for facial recognition of attendees to look for potential criminals. An automatic license plate reader is used in conjunction with video analytics reducing the necessary manpower in parking lots and redistributing personnel in the venue to interact with the public.

Editor's Note

Students noted that certain technologies they mention such as facial recognition and location tracking can be considered an invasion of privacy and may not be supported by the general public. However, these technologies were included in the analysis to be as thorough as possible.

Editor's Note
There are a variety of departmental financial tools that can facilitate technology upgrades, such as: grants, asset forfeiture, and general funds.

Inventory of assets

Students interviewed project liaison Lieutenant Anthony Wolfe to complete the Police Department inventory of assets. Unlike the Fire Department, there is no official technology committee on the Peoria Police Force. As with any city priority, leadership must manage financial resources prudently, so tech upgrade decisions are influenced by budgetary constraints. Where it comes to acquiring new smart technologies, managers need to strike a balance between purchasing new technology and maintaining existing assets. Figure 8 details the Police Department's existing assets, divided into four categories.

Peoria Police Department assets include:

Communication	*Social media*	*Databases*	*Investigative software*
Long range radios Two drones (limited to SWAT level actions) Computer-aided dispatch systems (CAD)	Facebook page	Homegrown business analysis database State-run GIS Nextdoor (third party neighborhood security platform) Arizona Criminal Network	Smartphone cracking packages, such as Sylobyte and Morpho

Figure 8 *Inventory of assets developed by students in consultation with Peoria Police Department staff*

Gap analysis

Police services currently utilize the Smart911 dispatch system, which allows departments to add data to the names and phone numbers of residents who self-register their phones. This system is generally considered to be underutilized by the public. Long-range radios provide connectivity between dispatch and officers throughout the jurisdiction, however **there are significant gaps particularly in the northern sectors of City.** There is a definite need for an increase in transmission towers for radios and the potential integration of city-issued smartphones to leverage cell phone devices for rapid communication, including photos and videos.

Excerpted from Beecher et al., p.12

The 911 calling system is currently experiencing a nationwide upgrade, termed Next Generation 911. It is replacing antiquated analog 911 infrastructure with an internet protocol-based system that allows for more data-rich communication where callers can submit photos, video and text. It is currently in progress at the sub-state level for Arizona, which means Peoria will benefit from the system in the near future. This is a key part of smart city progression for both police and fire services.

Lack of definitive policy regarding current and future technologies present the biggest limitations on integration of smart devices and data collection necessary to realize the goal of becoming a Smart City. For example, the department owns two drones, but due to perceived public privacy concerns they are not utilized in normal policing activities and are reserved solely for SWAT level events. Facial recognition packages are available, but there is no signal from lawmakers on how their use will be viewed, rendering their integration into the force potentially fruitless. The same is true for automatic license plate readers.

Finally, police have no clear pathway for reviewing and determining how to best integrate technologies and mine the newly provided data. While the Fire Department has an IT committee, there is no equivalent for the Police Department. By creating a cross functional team to gather the needs of the force, issues such as these could be rapidly evaluated and determined.

Excerpted from Beecher et al., pp.6-7

Survey Analysis

Survey respondents reported a high level of comfort with the idea of the Peoria Police Department utilizing smart city technology. It can then be inferred that Peoria residents are aware of the importance of new technologies in public service. Similarly, Figure 8 supports the idea that community members prefer to engage with the Police Department online through social media and websites. However, there is still high fragmentation in the responses, which shows diverse communication visions among residents.

Peoria resident police communication insight

	First choice	*Second choice*	*Third choice*
Social media	23%	16%	8%
Traditional meetings	16%	11%	14%
Website	14%	20%	12%
Public service programs	8%	16%	15%
Volunteer/charity work	9%	13%	13%
Social events	7%	8%	18%
Mobile app	9%	10%	17%
Video chat	1%	1%	>1%
Phone call	12%	5%	3%

Figure 9 *Respondents rank preferred communication methods with the Peoria Police Department*
"What is your preferred method of engagement with the Police Department?" n=317

Unfortunately, respondents ranked their actual level of engagement with police as low, with 84% reporting in the average to very low range. This presents a clear opportunity for the Peoria Police Department to increase their communication efforts with their community.

Police Department SWOT analysis

Strengths

The City is **legally mandated** to provide police service, eliminating the debate about the long-term viability of the organization.

The Police Department has over 200 working officers and has **maintained high ethical standards.**

Electronic communications are widely used. Patrol vehicles are equipped with computers and use a police-specific enterprise resource program (ERP). Radios are provided for communication across service areas.

The department is **willing to explore new technology** and its different uses. Resistance to change was not apparent, as body cameras, social media resources, drones, and smart phone uses are being embraced.

Weaknesses

The department owns two drones which can only be used in SWAT situations due to **privacy concerns.** Facial recognition capability is not currently adopted in sports venues for similar reasons.

Access to smartphones for patrol officers has been problematic, due to rules of discovery and other concerns.

The department has not transitioned from older license plate reader technology to more current offerings. There are new technologies available to enhance policing, but there is **a need for better planning and coordination** with guidelines on how to propose, evaluate, and integrate new technology into the workforce.

Peoria has a **large geographic footprint,** divided into 18 districts totaling almost 180 square miles. The majority of this area is in the sparsely populated Northern Districts. The department does an excellent job focusing resources on critical areas and relies on a variety of methods to respond to less populated areas.

Opportunities

New transformative technologies in the policing sector could greatly enhance efficiency, effectiveness, and safety of the police force. These "Internet of Things" (IoT) devices (e.g., automated iris readers, license plate software, facial recognition software, infrared cable drones) could allow for rapid determination of threat levels, property crime, and fugitive identification.

The current police workforce is **familiar with the internet age** and is ready to learn the necessary skills to fully utilize the capabilities afforded by the "Internet of things".

Community data collection could be used to strategically place officers in critical areas to better serve the community. Current data collection is often skewed to indicate where crime is reported, not where it occurs.

Threats

Police in general have been suffering from poor **public relations** for the last several years. It will be difficult to spur policy changes that can be perceived as intrusive, without a clear demonstration of how it improves overall quality of life for citizens.

Finding the necessary funds to purchase and integrate new technologies will be difficult and require patience (several budgetary cycles) to fully implement. Demonstrating a clear return on investment is essential on each of these technologies.

Smart technologies are rapidly changing and **product lifecycles** are difficult to predict. Time of investment will be a critical discussion point and can present a paralytic to decision makers if not properly managed.

Recommendations

- Increase connectivity of existing assets to help integrate communication resources across Peoria. Identifying gaps and subsequently installing repeater stations where there is a lack of direct line of site communication will have a tremendous impact.
- Create a social media strategy that recognizes the multitude of available platforms (e.g., Twitter, Instagram, and Pinterest) to better embed the police force with the next generation of citizens.
- Determine the legal framework under which the suggested smart technologies can be implemented. Address privacy concerns, implementation strategies, and changes to the municipal code through a commission by the City Council to help decision makers better understand their constraints.
- Establish an information technology (IT) committee comprised of a cross-section of police detectives, patrolmen, District Attorney's office employees, and the City Manager's representative; consider involving external stakeholders with technology expertise. This committee should begin evaluating which technologies merit further study and which ones should be purchased immediately.
- Consider the balance between privacy and public service, and customize new technology implementation to the specific wants and needs of the Peoria residents.

Iconic spaces

The phrase "Iconic space" was used to refer to Peoria's myriad of assets that provide recreational and entertainment opportunities. This report focuses on three major iconic spaces, the Peoria Sports Complex, Peoria Center for the Performing Arts, and P83 entertainment district. These spaces will be evaluated for their ability to provide opportunities to both entertain and inspire residents to engage with the community. Additionally, attention will be paid to operational efficiency of the venues.

PEORIA SPORTS COMPLEX

Visioning exercise

As a city-owned asset, the Peoria Sports Complex (PSC) poses a high-impact opportunity as a public interface with residents. The City can leverage this opportunity to showcase high standards of technologies, innovations, and data analytic strategies to:

- Optimize efficacy and efficiency in its operations, programs, and systems
- Foster community and economic development, sustainability, equity, and inclusivity
- And continually improve the overall well-being of the community.

In an ideal envisioned state, PSC operation processes can be digitized and mostly automated. Programs and interfaces should be streamlined to ensure minimal interference and invisibility on the backend of all services. Through the popularity of PSC, this space fosters community development and well-being through high and effortless usage for all members of the community.

Inventory of assets

The PSC uses a variety of apps and technologies to optimize their operations and services. Most of the technologies are applied in the recently renovated and LEED+ certified Clubhouses for the San Diego Padres and the Seattle Mariners.

Peoria Sports Complex assets include:	
Struxureware-Schneier Electric facility management software	Allows precise and real-time analysis and management of the HVAC system
Cisco AnyConnect	Allows protected remote access to HVAC systems in both clubhouses Analyzes real-time data, including temperature, air quality, and carbon dioxide concentration to adjust individual units for optimal effectiveness Manages operation times between all units to lower energy consumption
Musco Control-Link	Schedules and controls field lighting for stadium and practice fields Allows individual lights to be activated and scheduled, increasing energy efficiency
Maxicom system	Schedules irrigation of all fields
BECS system	Monitors pool chemicals for all facility pools Can be managed remotely
When2Work	Schedules employee work hours in a collaborative and agile way
Daktronics	Controls the state-of-the-art videoboard
Electronic ticketing system through Tickets.com and Provenue	Allows for analysis of buying trends Suggests discounts and coupons for individual buyers or target groups

Figure 10 *Inventory of assets developed by students in consultation with Peoria Sports Complex staff*

Gap analysis

State-of-the-art stadiums offer a variety of technologies and analytics to enhance visitor experience, general operations, and the state of the game. Wi-Fi and a stadium or team app are the most common tools to increase younger fans' interest in the featured sports and visiting the stadium. Specifically, apps can have a range of interesting and helpful features such as pre-ordering food at the concessions or requesting delivery, or enabling fans to see plays from different angles on demand and view player stats. An interactive map can help fans find their seats and even locate the shortest concessions or bathroom line. In some cases, fans can even connect with other fans in the stadium through a social media hub, and gain access to a live player chat during, before, or after the game. Lastly, the access to hundreds of smartphone cameras provides new features for attractions such as multi-angle filming, or selfies and video board streaming through your own phone.

Facility operations can be optimized through advanced analytics of ticket sales and other data like weather, traffic, time of day, and alternative programs. Seat heat maps and real-time analytics can help staff manage traffic after the game, parking, concession stocks and general trouble shooting.

Lastly, game analysis can not only benefit the visitor experience, but also the teams. Advanced cameras allow for detailed analysis of technique and player tendencies. Coaches can specifically target training for hand position, release point, spin, ball speed or break by studying state-of-the-art film allowing to visualize details impossible to see with the naked eye.

Figure 11 *A packed day during Spring Training at the Peoria Sports Complex, by City of Peoria*

Peoria Sports Complex SWOT analysis
Strengths
Seasonally sensitive fields through winter and summer grass.
Scheduled irrigation (Maxicom) and field lighting (Musco), and the Schneider Electric Energy Management System (HVAC, Lighting, Controlling, Billing) contribute to financial savings through management of energy consumption.
Automatization through communication between individual devices and services.
Agile seasonal worker scheduling (when2work).
60-70% of ticket sales are online, monitored and analyzed (Tickets.com).
Trend analysis and individual promotion recommendations (provenue).
Great reputation and appreciation for the Peoria Sports Complex.
Weaknesses
No sensoring or smart meters for irrigation (soil moisture sensors).
No Wi-Fi or Geofencing.
No way to inform about public safety protocols.
No civic reporting.
Issues with light scheduling extensions (overtime) requires personal calls to adjust scheduling (Musco).
When2work lacks compatibility with ADP.
Extreme water needs.
Ticketing and renting of VIP areas requires manpower.
No cameras around the stadium.
Limited shade areas.
Opportunities
Contract extensions of the Seattle Mariners and the San Diego Padres until 2034.
Scaling of Schneider Electronics from the Club Houses to the stadium.
Replacement of grass with (partly) artificial turf and desert environments.
Mobile Pay and NFC to simplify paying at concession stands.
Soil moisture sensors for increased efficiency of water usage.
Existing water meter database for increased efficiency of water usage.
Increased attractiveness of Peoria increases revenue of event locations.
Threats
The hot, dry climate threatens visitor numbers and increases water scarcity.
Limited public involvement (not a public space).
Competition for event locations.
Decreased attractiveness of Peoria decreases revenue of event locations.

Recommendations

- Optimize water efficiency by using water management technology, such as soil moisture sensors and water meter analytics. This suggestion is especially prudent considering the uncertainties of future water availability in the valley.
- Partially replace grassy environments with artificial turf or desert landscaping to save water, provide less drought-sensitive fields, and reduce maintenance needs.
- Lower energy needs by further implementing Schneider Electric Energy Management System for HVAC and lighting control throughout the stadium. This system is currently only used for both facility clubhouses, but could be expanded to use in main facility. The economic benefits combined with the guaranteed long-term contract extensions makes implementation of the system highly beneficial.
- Invest in state-of-the-art visitor engagement technologies, such as Wi-Fi and an engaging mobile app for game day features, communication, and convenience. This strategy could help further develop the target audience of the year-round program at the Peoria Sports Complex.
- Consider implementing high-tech camera equipment for motion analytics, which could benefit the fans for entertainment as much as the teams, players and scouts for player evaluation and training.

PEORIA CENTER FOR THE PERFORMING ARTS

Visioning exercise

The Peoria Center for the Performing Arts (PCPA) is a place for the community to come together and celebrate theater, dance, music, and the creative venues of storytelling through the performing arts. PCPA is a public space that fosters inclusivity, collaboration, and civic engagement, aiming to improve and enrich the lives of Peoria community members through art and creative expression. In the technologically enhanced envisioned state, the Center engages its audiences through augmented and virtual reality technologies, as well as projection, sound, and lighting technologies, thereby creating unique and moving experiences to tell the stories of theater and performance. An award-winning sustainable design, the PCPA building provides unique indoor and outdoor spaces with the adjacent Osuna Park, where Peoria comes together to celebrate its community through numerous events and festivals.

Inventory of assets

PCPA is a staple in the Peoria community, and a vital part of Old Town Peoria. As it stands today, PCPA hosts a variety of shows and provides great services to community partners, from TheaterWorks, the managing theater company, to renting studios to dance groups. PCPA and nearby Osuna Park also play a crucial part in Old Town holiday celebrations, by facilitating a connection between community members and existing restaurants and businesses.

PCPA assets include:	
PCPA	Relatively new lighting and sound system Unique architecture that facilitates connection between the indoor and outdoor environments
Osuna Park	LED lighting Electronic water management system

Figure 12 *Inventory of assets developed by students in consultation with Peoria staff*

Gap analysis

PCPA and Osuna Park are important community spaces that would benefit from further integration of technology assets. Currently, both spaces could be updated with modern, useful technology that would increase traffic, provide a better visitor experience, and maximize facility sustainability. Both Osuna Park and PCPA have opportunities to expand their roles in placemaking, especially through connectivity and technology updates in the theaters, studios, and lobby space which connects the building to the park. While the building's sound and lighting systems are fairly new and function well, technology could be further employed to truly facilitate a unique experience of the theater spaces. In Osuna Park, little technology is in place aside from the lighting and a water management systems. This provides a substantial opportunity to expand technology use in the park to engage patrons and enhance their experience of the space. Currently internet and Wi-Fi connectivity is significantly limited at PCPA and Osuna Park. By increasing technologies in these areas, the City will greatly increase the PCPA experience for theater patrons, the overall community, and city staff working at either location.

Another opportunity to increase connectivity is the design of the physical space. The connection between PCPA and the park could be redesigned to allow for a more immersive experience. This new experience could be enhanced through technology to improve the quality of public events and expand on the public's engagement with PCPA and the park, creating further opportunities for experiential space making. **By expanding on those opportunities, PCPA and Osuna Park could become integral change agents that help revitalize Old Town Peoria.**

Peoria Center for the Performing Arts SWOT analysis
Strengths
The building and theater equipment is **relatively new**.
Lighting has been recently changed to LED throughout the building and surrounding park.
Ample space and flexible design allows for hosting a **variety of events** and programs, with some technologies provided to support the space (e.g., lighting and sound systems, projectors).
Technology for assisted listening increases **accessibility support.**
Projection technologies in the main theater are modern.
Codes on doors and entry points support **security of the site**.
Irrigation technology (Calsense) in Osuna Park is modern and functional.
Weaknesses
The building lacks adequate **internet access.**
Manual switching of lights in walkways **requires frequent attention** to navigate facilities.
Spaces **lack adequate technology support** for presentations and meetings, such as display monitors or sound systems, and some existing technologies are **outdated** (e.g., display screen outside the center).
Some technology equipment is owned by Theaterworks rather than the City, and is therefore **not integrated into the building**.
Opportunities
Integrating screens and displays into rooms could support programming (e.g, the meeting room lacks adequate technology support).
Technologies that support **accessibility and wayfinding** within the building could dramatically improve user experience (e.g., sensor lighting).
Projection and lighting design technologies in theaters could be updated to accommodate a greater variety of shows and provide better user experience.
The lobby area and surrounding park could become more **interactive and engaging** through technologies and screen displays.
Threats
Equipment owned by Theaterworks will become inaccessible once their contract with the City ends.
Community engagement, particularly with youth, may suffer if facility technologies are limited and not enhanced. Community engagement may also suffer due to nearby development being at a standstill.
Limited internet support may result in delays for facility staff and renders the facility outdated.

Recommendations

- Install motion-activated lighting to facilitate better navigation of spaces, especially the dark hallways leading to theater spaces. Dimmable lighting is recommended so as not to interfere with shows and theater lighting.
- Invest in a smart screen touch display and an additional movable screen. These items would be useful for meetings, groups renting studio spaces, or as interactive tools in the lobby space.
- Install an acoustic control system in the lobby, comprised of acoustic ceiling panels and smart speakers, to enhance the audial experience of the space and allow for more diverse utility.
- Update PCPA's outdoor sign to an LED display screen to provide higher visibility and engagement.
- Provide Wi-Fi both within the PCPA building and throughout Osuna Park to better engage patrons and the community during events. Wi-Fi in these areas also creates opportunities for additional programming during events, such as social media engagement or photo booths with instant image uploads.
- Utilize augmented reality and Virtual Reality (VR) technologies during performances to attract patrons to the theater for an enhanced storytelling experience and unique productions. Shows that utilize this technology could also benefit from reduced set-building costs.
- Improve the existing projection technology, potentially with multiple projectors, to enhance the visual engagement of the audience and overall experience of the theater.
- Use lighting design technology, such as laser projection lighting, in Osuna Park to support performances or events in an entertaining way. For example, themed projections could be displayed on the PCPA building as a backdrop during community events, or new lighting systems could support outdoor performances where the park itself becomes the stage.
- Improve park lighting by layering lighting levels to assist with wayfinding and extend the hours of park usage. There are also LED lighting options that integrate speakers which may be useful for the park.
- Install outdoor sound systems to encourage the growth of programming and events in the park, and potentially increase the types of performances that can be hosted outdoors. Many available outdoor sound systems are controlled remotely, are easy to calibrate for different uses, and only require minor infrastructure to be installed.

Editor's Note
Osuna Park poses an interesting opportunity to offer performances or events during the COVID-19 pandemic, where hosting events outdoors can help facilitate social distancing.

P83 RETAIL AND ENTERTAINMENT DISTRICT

Visioning exercise

The P83 Entertainment District facilitates economic development and social interaction for residents and visitors of Peoria. By incorporating Smart City design principles and technologies into the district, its sense of place can be further developed. In an ideal, envisioned state, new technologies and designs will make it easier and more comfortable to travel between businesses and other attractions while engaging with the unique qualities of Peoria's identity. Public Wi-Fi, waste sensors, security cameras, and HAWK (High-Intensity Activated CrossWalK Beacon) signals will make the spaces throughout P83 a desirable space to stay and interact with others. Existing and future fiber networks can allow for greater connectivity between organizations and businesses within the P83 development. This allows for a greater breadth of attractions within this public space including potential corporate campuses. These technologies will accent the infill development and economic growth that P83 will likely see in the future, to develop the space as an iconic destination within Peoria.

Figure 13 *Welcome monument to the P83 District, by City of Peoria*

Inventory of assets

In its current state, the existing technology in the P83 Entertainment District is relatively limited. Some businesses are tech-based (e.g., Modern Round), and there are some mobile applications that play a role within the district (e.g., POGO). However, there is room for improvement in pedestrian experience (e.g., safety features), the district's social media presence, and further use of placemaking principles.

P83 assets include:	
Tech-based businesses	Some businesses like Modern Round (a video game focused restaurant and entertainment venue) use technology to attract guests and increase their entertainment value
LED street parking	Traditional lighting is used on main streets Select pedestrian paths feature some human-scale lighting
Relevant mobile applications - Peoria on the Go (POGO) app and Peoria Reporter apps	The POGO app assists with transportation to the area and helps visitors plan trips to P83 by posting transit schedules and tracking vehicles The Peoria Reporter app promotes safety in the district by allowing residents to submit reports on anything from broken streetlights to suspicious activity
Traffic enforcement cameras	Signaled intersections (75/Paradise, 83/Mariners, and 83/Paradise) feature traffic enforcement cameras Cameras have limited storage
Fiber network	Allows for efficient communication and connection between businesses and organizations in the area
Social media platforms (Facebook, Peoria Newsroom)	Used to promote events in the district

Figure 14 *Inventory of assets developed by students in consultation with Peoria staff*

Gap analysis

The P83 District is quite economically successful, however there is still opportunity to further develop the space by introducing Smart City design principles and technology. **There is a latent demand for economic activity and social interaction which can be unlocked through physical adjustments to P83.** The goal is for P83 to develop into a major destination in the Phoenix Metro Area by improving its number of quality attractions and creating a unique sense of place. Currently, technology is rather limited in respect to enhancing public spaces to encourage different activities, such as shopping, working, and socializing. However, some technology elements can offer multiple benefits by also improving a space's physical characteristics.

P83 currently hosts a large amount of empty space that is dedicated to parking, and less than favorable pedestrian conditions. This may not affect residents looking to stop for dinner or a movie, but it is detrimental to visitors who want to walk around and explore the options throughout the district. The addition of pedestrian-focused technology, such as more HAWK signals and human-scale lighting fixtures, can encourage foot traffic between attractions in the district. Increasing wayfinding elements, such as maps and destination guides, would also encourage exploration of the District. Together, these elements promote the use of the P83 area as a social public space.

Additional security features may also promote further comfort and usage of the District. Introducing a security team, cameras, or help kiosks could increase the sense of safety for visitors as well as provide practical assistance. Free public Wi-Fi could not only facilitate the use of other smart technologies, but also attract visitors to stay in the space longer. Lastly, small tech amenities, such as cooling misters, charging stations, and trash can fill sensors, would be beneficial additions to the space. These enhancements will help define the P83 district and highlight its unique, tech-savvy characteristics.

P83 SWOT analysis

Strengths

P83 is popular for dining, shopping, and entertainment, seeing regular foot traffic and positive online reviews.

The area is very **clean and has unique design features**. Wayfinding signs and light fixtures near the entrances indicate arrival at the P83 District. This sense of place is important for any successful public space.

There are **very few empty properties** at P83, lending to a feeling of prosperity and activity.

The **POGO public circulator** provides access to P83, making many stops throughout the district.

There are **many attractions near P83** (Arrowhead Mall, Skunk Creek Trail, housing complexes). Connecting with these sites could facilitate greater use of P83 and its public space.

Weaknesses

There are **few spaces** for public activity that do not necessitate the purchase of a product or service. The outdoor plaza in front of the Arrowhead Harkins is the best example of how these spaces should look. There is also **little variety in the attractions at P83**, mostly consisting of entertainment and dining options. More functional destinations could increase traffic, promote community interaction, and create a sense of place.

Pedestrian connections feature poor lighting, long distances, and proximity to high-speed traffic.

Services like the POGO app and Peoria Reporter app need improved. Marketing projects, like the Peoria Newsroom, should use creative mediums to better promote events.

An estimated **50% of P83 land area is for parking.** Priced parking and increased POGO service could reduce the need for large parking lots, while infill development could encourage walkability, reduce extreme heat impacts, and encourage social activity.

Some articles state P83 **lacks a sense of place**, and tries to balance multiple identities. Creating space for different uses, and increasing P83-specific design features, could differentiate it from other economic centers.

Opportunities

Pedestrian-scale **light fixtures** along walkways could promote safety and encourage movement between attractions. Unique lighting features can also contribute to a sense of place.

Security technologies (e.g., cameras, noise sensors, security team) can improve comfort and safety.

The POGO and Peoria Reporter apps can be improved in both style and functionality. The POGO app is confusing to those unfamiliar with public transportation, and its layout is difficult to navigate. The Peoria Reporter app works well, but needs greater follow through with its customers.

Social media and online marketing could promote events and handle resident concerns, which could encourage more residents to become involved in their public spaces. By making better use of online features, events at P83 and other public spaces can increase attendance and community involvement.

Adding **pedestrian safety features** (e.g., HAWK signals, in-street lighting along crosswalks). would help make the environment more friendly toward young children, the elderly, and people with disabilities.

Free, high-speed, **public Wi-Fi** could encourage people to visit, and perhaps stay longer.

Establishing P83 as a **smart public space** by including relevant, functional technologies (e.g., trash can sensors, charging stations) can improve public perception and generate interest in visiting.

Threats

Funding for new technologies may be difficult to obtain. One option is to partner with local businesses.

Several suggested safety features (e.g., cameras and noise sensors) could raise **privacy concerns.** It's suggested to first explore options such as ASU's blue light system, or security guards.

Suggested features may draw **public opposition,** especially those which affect automobile traffic. Downtown Gilbert is a good example of how to accomplish this type of public space in a suburban community.

There are likely existing policies that need addressed to implement the recommended technologies.

Recommendations

Many of the technologies are intended to encourage traveling throughout the District, socializing amongst its public space, and economic development for its businesses. Below is a list of the recommended technologies to promote the increased use of P83 as a public space.

- Introduce technologies throughout the District that improve the quality of public space, such as free public Wi-Fi, cooling misters, waste bin sensors, and security measures (e.g., cameras, help kiosks, or security staff).
- Encourage pedestrian travel throughout the District by implementing features such as HAWK signals along major thoroughfares, traffic enforcement cameras at busy pedestrian crossings, and human-scale lighting features such as bollards or small light poles.
- Facilitate use of P83 as a public space by improving existing relevant mobile applications, such as Peoria on the Go (POGO) and the Peoria Reporter app.
- Invest in marketing and social media campaigns for public spaces throughout Peoria, including P83, to spark public interest in visiting the District.

Public amenities

Certain public amenities help build a city's identity while simultaneously providing necessary recreational and educational services to residents and visitors. For Peoria specifically, its trails, parks, and libraries are considered to be extremely useful and loved public spaces. Just like the previously described iconic spaces and public safety departments, these public amenities can also be enhanced through smart city technology.

Excerpted from Napolitano et al., p.10

Survey Analysis

Students developed questions for the F19 omnibus survey that specifically addressed technology in public amenities. It was determined that respondents were generally interested in most of the proposed smart city technologies specific to trails, parks, and libraries. These results help illustrate the willingness of Peoria residents to implement smart technologies throughout their community.

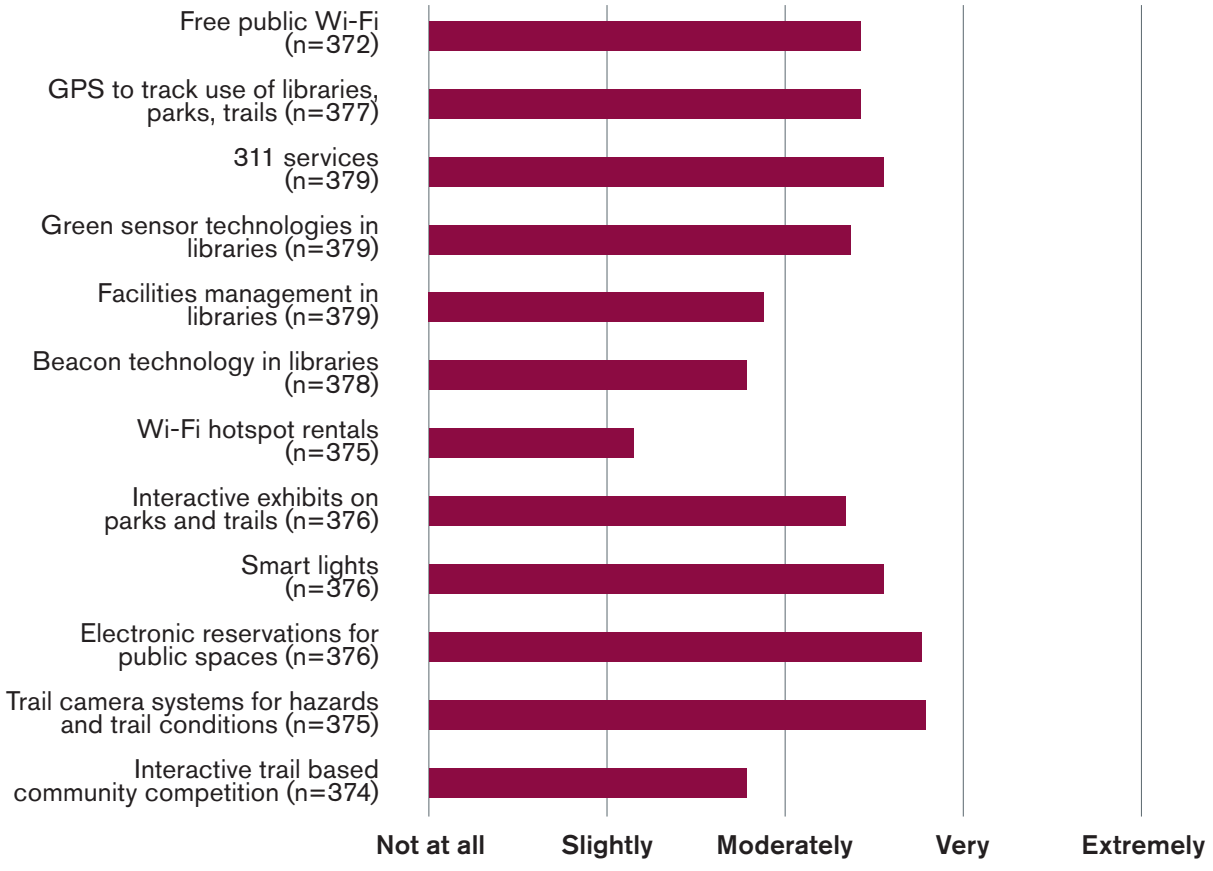

Figure 15 *Average overall results of community interest in various smart technologies*

TRAILS

Peoria's trails and off-road pathways give residents and visitors access to over 20 miles of multi-use trails for walking, jogging, hiking, cycling, and horseback riding. From public to private, and urban to off-road, **these trails are important places of movement and communal interaction,** and subsequently are key spaces for Peoria to garner feedback for the continual improvement of its residents' well-being.

This assessment focuses on Peoria's New River Trail (NRT), a 16.8 mile, moderately trafficked, multi-use pathway that runs North to South, adjacent to the New River. The paved trail is primarily used for hiking, walking, jogging, and cycling, and is accessible year-round. Its proximity to neighborhoods, popular public and recreational spaces, and key city services, makes the NRT a prime target area for the efficient integration of smart technologies.

The NRT is among the most popular trails in Peoria due to its proximity and connectivity to high-population areas of the city, separation from common pedestrian traffic hazards, and its semi-urban, semi-wild appeal. It is a short distance from shopping centers, such as Westgate, the University of Phoenix Stadium, Park West, Arrowhead Towne Center, and P83. The NRT is also connected to Peoria's Skunk Creek Trailhead and the Grand Canal Linear Trail, which extends through Tempe, Phoenix, and Glendale. Due to its proximity to the New River, the trail area is also home to diverse flora and fauna.

Figure 16 *A section of Peoria's New River Trail showing an existing trail marker, from original student presentation*

Visioning exercise

Trails have high potential for smart technology integration. In the NRT envisioned state, trail analytics such as traffic and temperature could be collected through sensors along the NRT and shared with the public or used to support municipal projects. Trail users can become more involved in area development by providing feedback about their experiences to the City, perhaps through a streamlined mobile application. This information can then be used to efficiently prioritize improvement areas. This user feedback mechanism combined with sensor-collected trail analytics will assist Peoria in maintaining strategic, sustainable, and equitable urban growth.

Deployment of small cell technologies throughout the NRT can provide enhanced cellular coverage and facilitate the development of a 5G system to accommodate implementation of the Internet of Things (IoT). This increase in connectivity and communication has many valuable opportunities. Through mobile apps or digital trail signage, Peoria could notify users of valuable safety and health information or nearby points of interest. A 5G network could support the system of trail sensors and enable many smart city applications, all while users enjoy faster connections, greater reliability, and more interactive capacity.

Strategically placed urban ecological infrastructure (e.g., cooling areas or cool corridors) could reduce the effects of extreme heat and promote trail usage near public areas of value, such as P83 and Old Town. This infrastructure would ideally be integrated into the park design to maintain the trail area's natural aesthetic. Updated and accessible GIS trail mapping would also be available for users to learn about their desired routes. Through these smart technologies, the NRT can be safer, more connected, comfortable, and popular.

Inventory of assets

Through online research, interviews with Peoria staff, and site-visits, several New River Trail (NRT) assets were identified. These assets are mostly technology-based services and infrastructure currently utilized by Peoria on the NRT. The inventory of assets helps explain what the NRT has and can improve, or what the NRT lacks and could integrate. Assets on the NRT can be broken into two categories; physical assets, or on-trail infrastructure; and e-based technology services that can be accessed online or through mobile apps. Figure 17 on the following page lists these assets.

New River Trail (NRT) assets include:		
Physical assets	***Electric trail counters***	Record foot traffic Usually located near trailheads Help establish trail usage and can be used for strategic planning
	Signage and trail markers	Located throughout the NRT, especially at popular trail entrances Signage provides a map of the trail and surrounding area Lists NRT rules and expectations Explains trail difficulty rating Provides a warning of heat-related risks Offers great potential for incorporating smart technologies Mile markers offer location indicators for emergency service calls
E-based assets	***Interactive ArcGIS map***	Hosted on the City of Peoria website Includes the entire Peoria trail system Can help locate trails and parks, bus and transit routes, and major roadways Can be difficult to use and certain functions do not work well (e.g., searching for specific locations)
	Peoria Reporter app	Free mobile app Users can report damages or concerns about Peoria locations, contact city departments, or simply learn more about Peoria
	GIS software	Used to map and implement urban forestry programs
	Relevant third-party apps	External apps that are not affiliated with the City of Peoria, such as AllTrails and Stava, can also provide information about the NRT

Figure 17 *Inventory of assets developed by students in consultation with Peoria staff*

Gap analysis

Currently, the NRT lacks safety-related services and infrastructure, such as trailside lighting, real-time heat advisory notifications, benches, and water fountains. NRT also lacks helpful services, such as accurate trail mapping, and adequate information and service infrastructure (e.g., mobile applications). Without these services, NRT users may be less informed and connected. To establish a "smart trail," it is suggested to implement trailside light fixtures and 911-connected blue light systems to increase nighttime security, functional online interactive trail maps, trailhead real-time heat advisory notifications, and online and mobile service app centricity. Furthermore, trail counters should be deployed to quantify high-use areas of the trail for future installments of the aforementioned services, along with benches, water fountains, and shade structures for user comfort.

Figure 18 *Example of existing shade structures in place at the Peoria Fusion Demonstration Garden. Similar structures could be strategically implemented on the NRT to increase user comfort, and potentially connect to the IoT via small cell technologies, by City of Peoria.*

New River Trail SWOT analysis

Strengths

The NRT is popular according to resident surveys and online reviews. When asked what outdoor recreation activities residents would most enjoy in their area, many respondents recognized the utility that trails provide.

Physical infrastructure throughout NRT, such as trail markers and signage, are useful tools that can be improved through technology. Other assets like trail counters could record metrics for future strategic planning.

Electronic-based services allow NRT users to provide feedback through mobile apps and online resident portals on the Peoria website. Already established, these assets are readily open for improvements.

The NRT has **high connectivity**, running along recreation hubs, neighborhoods, and businesses, and connecting to the Grand Canal Linear Trail which extends through Tempe, Phoenix, and Glendale.

The NRT is **separated from major roads** and buffered from smaller roads and neighborhoods, which is appealing to those who prefer protected pedestrian/bike travel and less traffic signals.

The NRT provides users with **several recreation options**, such as equestrian use and bicycle use, which increases accessibility and opportunities for smart technology integration.

Weaknesses

There is no apparent **energy infrastructure** along the NRT. This may delay immediate implementation of technology that requires connection to the electrical grid.

Although the trails officially close at dusk, residents express **safety and accessibility concerns** on the NRT related to lack of lighting.

Despite running along key public space assets and natural areas (e.g., P83, Rio Vista Park, New River's Riparian bank), there is **little information available** about area habitats and wildlife.

Much of the NRT lacks **heat-safety infrastructure** (e.g., water fountains, benches, shade structures).

The **online trail map** is difficult to use and does not have a friendly mobile interface. Searching for a location on the map returns a 'not found' message, and the legend is overly complex.

Opportunities

There is no existing power grid along trails like New River, providing ease of technology **infrastructure installation**, without removal of old infrastructure. Small-cell technology and off-grid urban designed solar smart poles are two features this opportunity presents context for.

Environmental data captured through GIS trail mapping, tree mapping, trail counting sensors, and mean radiant temperature (MRT) technologies can converge to increase thermal comfort along NRT. This data can help determine ideal locations for cooling structures, or inform users of the coolest routes.

Peoria survey respondents reported the trail system lacks a **sense of community**. Adding displays about the area's history, culture, or ecology is one way to build a sense of place.

Threats

Privacy concerns from adjacent homes may arise regarding light pollution, sensor installation, data collection, and sound pollution. Cameras, sensors, and increased security could also raise concern with NRT users.

The **multi-use** nature of the NRT means fast traffic like bikers need to be wary of slow traffic like walkers.

Lack of shade limits trail use, especially in warmer months. Adapting to high temperatures provides opportunity to utilize smart technologies.

Installing capital, especially power-based infrastructure, is **expensive**. Funding will have an effect on the rollout of smart technology, regardless of the project scope.

Implementing technology into an area **risks marginalizing poorer communities**. E-based assets could exclude groups who do not have access to internet on the NRT.

Recommendations

- Develop a communication channel, such as a mobile application, for the local trail system that allows information to pass from users to the city and vice-versa, bridging the gap between trail users, active conditions, and city services. Connect to useful assets within the app such as the Peoria Reporter app, an interactive trails map, or location-based educational opportunities.
- Replace static signage with location-specific digital displays that can teach users about the surrounding area as well as connect them to nearby alerts or updates, perhaps even through connection to the Peoria Reporter app.
- Update the interactive trail map on Peoria's website to be more user-friendly and informative. Specific improvements could include map layering, legend clarity, location tracking, and contextual information. The map should also include displays for data collected by trail sensors, such as current trail traffic and ambient temperatures. Updates should be compatible with both stationary and mobile devices.
- Expand educational and informational services to help users feel more involved in shaping their environments. Investigate the Textizen app as an informational tool to link citizens to public works projects. The app can provide information, offer surveys to gather community input, and provide alerts about project progress. Alternatively, consider implementing similar utilities within the Peoria Reporter app.
- Add QR codes to strategic locations (e.g., signage or trail markers) to share information on certain locations or features. QR codes could link to Peoria's website, or a mobile application.
- Implement a bike-share program to increase trail usage and connectivity while providing an alternative mode of transportation.
- Strategically install sensors throughout the NRT to record heat and other environmental hazards and use the collected data to alert users to unfavorable or dangerous conditions through mobile apps, the Peoria website, and digital trail signage.
- Utilize data collected from trail counters, mean radiant temperature (MRT) technology, tree mapping, and GIS trail mapping to improve user comfort. For example, MRT data measured at high traffic areas can help identify ideal locations for cooling structures, and tree mapping combined with GIS technology can help identify shaded routes that are safer for summer usage.

- Work with wireless carriers to deploy small cell technology on existing trail infrastructure to improve signal strength and support connectivity throughout the trail. Small cell technology could also improve trail sensor performance and data accessibility, enabling city decision-makers to respond quickly to potential hazards or shifts in user demand.
- *Install solar path lights along trails to provide energy-efficient lighting and increase user comfort and safety in the evening hours (Napolitano et al., p.7).*

PARKS

Parks are community hubs that enhance social connectivity and provide recreational opportunities. They are nodes for transportation integration, community health, and civic engagement. Parks are influential centers for all community members, providing space for parties, outings, company events, and more. These public spaces shape the physical and social environment of communities. Peoria has 36 neighborhood parks and 2 large community parks which are access points for over 20 miles of public trails. For brevity and efficiency, only Rio Vista and Pioneer community parks will be assessed in this report for their capacity to implement both technological and non-technological improvements.

Figure 19 *Peoria's Rio Vista Recreation Center and Pioneer Park splash pad, by City of Peoria*

Visioning exercise

Rio Vista and Pioneer parks have ample space to improve safety, accessibility, health and wellness, energy efficiency, and interactivity. In their envisioned states, the use of multi-language signs to accommodate Spanish speaking and visually impaired residents would support accessibility by acknowledging diversity and championing inclusivity. Promoting partnerships with local vendors through shared concession stands supports community health and wellness by providing more healthy food options and simultaneously supports community building by valuing local entrepreneurs. Integrating interactive play structures and smart benches can increase digital interactivity within the parks. Renewable energy can be promoted by incorporating solar photovoltaic panels on shade structures to power clean energy charging stations. Energy efficiency can further be supported by expanding Musco lighting across all fields in both parks. These improvements will undoubtedly foster a greater sense of community and increase community engagement.

Excerpted from Napolitano et al., pp.3-4

Luminescent paint, such as the Dynamic Paint developed by Studio Roosegaarde, could also increase safety and comfort in parks and public spaces. The paint absorbs solar energy throughout the day and glows in the dark for up to 10 hours. This provides an energy-efficient option of illuminating walkways and other low-traffic public amenities while decreasing electricity costs and light pollution. There is also opportunity to use this technology to highlight cultural assets, as the Dutch Town of Eindhoven did with the Van Gogh bike path.

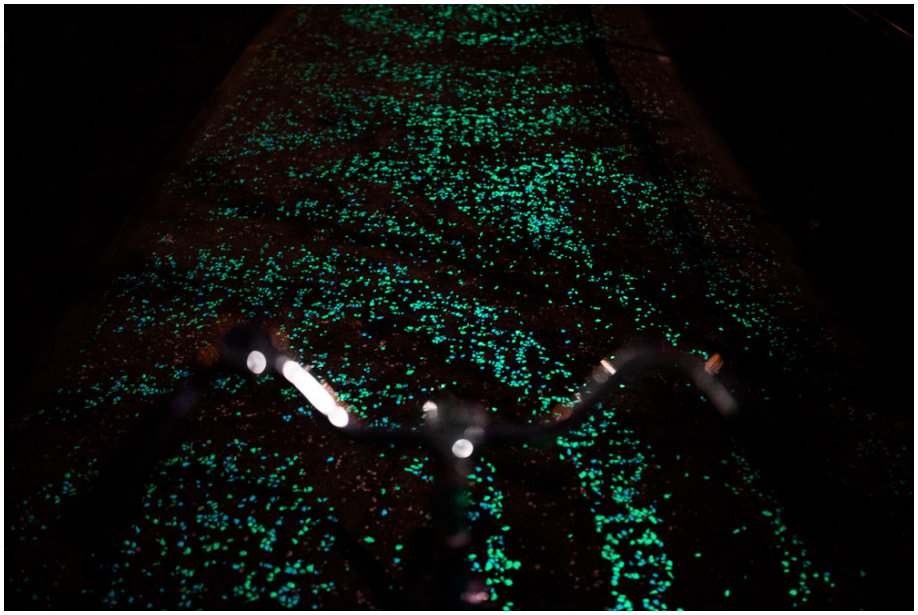

Figure 20 *The glow-in-the-dark Van Gogh bike path in Eindhoven, by Studio Roosegaarde via Flickr*

Energy harvesting tiles are also an interesting technology that could be implemented into parks and public spaces. The tiles harness energy as they are walked on, with each footstep generating about five watts of power. Tiles like this could be installed in playgrounds as interactive play features that light up or play sound as they are stepped on.

Inventory of assets

Rio Vista Park is a 52-acre park with a 2.5-acre urban lake. It has a recreation center and is home to the Veterans Memorial wall. It has the standard amenities associated with a park including group and individual picnic areas, sand volleyball courts, a playground/tot lot, a skate park, several softball fields, multi-purpose sports fields, a splash park, walking paths, batting cages, and an orienteering course. It possesses little technology to be evaluated for the purposes of this report.

Figure 21 *Rio Vista Skate Park by Ms. Phoenix via Flickr*

Pioneer Community Park is an 83-acre park with a 5-acre urban lake and possesses many of the same features as Rio Vista Park. There are six ball fields, a dog park, several multi-purpose fields, picnic ramadas, swing sets, a splash pad, and a heritage court for small events. Again, the park features little technology to be evaluated for the purpose of this report.

Gap analysis

The two parks feature a myriad of recreational options for residents, but the only technology currently utilized is the ability to reserve a ramada online. Ideally, residents would be connected to the parks through a reliable transportation system. Data can be collected from users either through online reviews or a city app to allow park managers to make informed decisions on improvements. Park signage currently lacks inclusivity and could incorporate information in Spanish as well as English to serve the communities' growing Spanish speaking demographic. New solar shade structures could provide energy efficient charging stations and Wi-Fi capabilities, and digital kiosks throughout the parks could provide access to city services. Cameras and emergency beacons throughout the park would also help citizens feel comfortable and safe.

Excerpted from Napolitano et al., p.2

A potential option to efficiently increase Wi-Fi connectivity in parks is "solar trees". These aesthetically pleasing structures absorb solar energy and can be used for their stored energy and as sustainable public lighting. At the time this report was written, solar trees from various companies are generally still in the prototype phase and are not yet being mass produced. Smart Palms and VTREE Solar are two promising producers that have implemented their prototypes across Europe and the United Arab Emirates. VTREE prototypes are currently available for preorder starting at approximately $35,500. Current prototypes can feature: Wi-Fi hotspots, security cameras, solar panels, touch screen and smart information applications, digital outdoor screens, and charging stations.

Figure 22 *An example of a solar tree with seating, by ricrossi via Wikimedia Commons*

Parks SWOT analysis

Strengths

Irrigation is on a centralized system, managed by the City. Water meters are distributed throughout the park. Captured data helps conserve water by accommodating appropriate water distribution for field maintenance. Similarly, the lake's water levels facilitate water distribution for irrigation.

Rio Vista softball and soccer fields use **smart lighting** (Musco). This includes LED lights with timers and brightness controls. It is suggested to extend these lighting technologies to high-use fields in Pioneer Park.

Urban fishing is popular at both parks. To fish, a permit needs to be obtained. Providing hard copy applications in English and Spanish with submission instructions would promote inclusivity and accessibility.

Both parks are **popular and see a consistent user base**. The most used fields on weekends are softball/baseball fields, and both parks have plenty of public ramadas. Both parks most likely share similar user trends, despite Google reviews reporting Rio Vista Park's highest traffic around 7:00pm, compared to Pioneer Park which sees the most traffic around noon.

Both parks have **large parking lots** that accommodate a large user base.

Weaknesses

Both parks **lack interactive play structures**, instead featuring traditional play equipment. Pioneer Park specifically had an underwhelming play area. Neither park included digital play structures.

There are **no surveillance cameras** at either park. Surveillance is suggested for parking lots, which are isolated and may have a higher likelihood of crime. Sports field cameras can also be used to record games.

There are **no user monitoring** features allowing Peoria to track amenity usage, which could guide renovation efforts based on priority. Cameras with tracking software can be fitted on existing structures to determine the user base of an amenity and guide resource allocation. Parks and Recreation can oversee this data.

Park signage lacks inclusivity. They are in English only, which excludes the Spanish-speaking demographic of Peoria, as well as any visually impaired visitors. Rio Vista signs are also worn down and could be replaced.

Pioneer Park is **lacking in visual aesthetics,** and appears rather dull when compared to Rio Vista Park, which features a desert color palette throughout, and feels more welcoming, modern, and new.

Both urban lakes **lack shade** and Pioneer Park specifically lacks shade around sidewalks.

Opportunities

Offering public Wi-Fi throughout parks would benefit visitors, especially those without at-home internet access. A Wi-Fi network would also allow park smart features to connect to the internet.

Replacing existing shade structures with **solar shade structures** could allow people to charge their devices. Wi-Fi routers can also be attached to allow for Wi-Fi powered by clean energy.

Concession stands should offer a wider variety of healthy foods to encourage better eating habits. Concessions could also partner with local restaurants and vendors to support the local economy and increase a sense of community by getting to know local entrepreneurs.

Peoria could offer **free public health and wellness programs** in English and Spanish. Programs can utilize some of the large fields and help promote a sense of community.

Threats

Public **privacy concerns** could arise as the City collects data from cameras and sensors.

Opposition to new food vendors could occur as some people may not want existing options to change.

Some people may be **opposed to additional technology** in parks and outdoor recreation areas.

Extreme heat poses a threat, as neither park has much shade.

Recommendations

- Use existing infrastructure to implement new technologies, such as retrofitting sensors or security cameras to existing shade structures.
- Incorporate surveillance cameras in parking lots for safety and in high-use sports fields to potentially record games.
- Incorporate Musko lighting in all high-use fields and parking lots for energy efficiency and safety.
- Partner with local vendors for concession areas to promote community building and encourage healthy food options.
- Install solar shade structures in high-use areas, such as near sports fields, to provide charging stations to park users.
- Replace or retrofit existing standard play structures with interactive play structures that can be internet connected and programmed to feature various games.
- *Consider installing new, innovative technologies such as solar trees, luminescent paint, smart furniture, or energy harvesting tiles as they become available (Napolitano et al., pp. 2-4).*

LIBRARIES

The definition of a library is “A place in which literary, musical, artistic, or reference materials (such as books, manuscripts, recordings, or films) are kept for use but not for sale” (Merriam Webster). The public library occupies a unique place in the civic landscape. **Libraries can become a place where a community pools resources to create a space that fosters the betterment of individuals, which in turn enhances the quality of life throughout the community.** The public library caters to the needs and interests of the individual while offering a venue for community engagement. It is a place for learning, leisure, social interaction, personal growth and community improvement (Peoria Library Strategic Plan 2019). This section investigates how a library can leverage technology to meet both the traditional definition and the goals within the Peoria Library Strategic Plan.

Figure 23 *Sunrise Mountain Library, by Digital Bookmobile via Flickr*

Visioning exercise

The community-centric, multi-purpose functionality of libraries makes them the perfect space in which to implement Smart City principles. This section will focus on two primary considerations that would benefit from smart technologies: connectivity and accessibility. In terms of connectivity, both City libraries serve as resource hubs that connect Peoria residents to different opportunities around their community. However, there are not nearly as many provisions for accessibility as it relates to disability access. As a connection point to the arts and public services, Peoria’s libraries can become the key to healthy neighborhoods and community-facilitated economic development in their technology enhanced, envisioned states. Adequate accessibility is necessary for this to happen.

Excerpted from Napolitano et al., pp.4-6

In a modern, smart library, bulk separators, such as the flex AMH bulkSeparator, can streamline the library return process and maximize book sorting efficiency. In the same vein, automatic laptop and tablet dispensing kiosks can expedite the device checkout and return process while increasing the community's accessibility to technology. Smart furniture can also enhance connectivity within libraries. Installing interactive multi-touch tables can provide meaningful experiences for individuals or groups of all ages when used for games, research, design, brainstorming sessions, and so on. Peoria's libraries could also upgrade their current web platform to Polaris Leap to facilitate browser flexibility, mobile access, and simpler updates. Finally, smart libraries should have a strong e-book presence to increase accessibility of library materials.

Figure 24 *Tablet dispensing kiosk at the Austin Public Library, by Mike Russell via Wikimedia Commons*

Inventory of assets

Figure 25 displays the currently offered technologies and services at the Peoria Main Library and Sunrise Mountain Library. Through these amenities, Peoria has been able to assist their patrons with regular library needs and requirements.

	Library assets include:
Peoria Main Library	34 Sprint Mobile Hotspots
	73 public computers equipped with Microsoft Office programs
	Free public Wi-Fi
	Explore-To-Go kits
	E-Library services
	Charging ports with regular outlets and USB plugs at library tables
	6 AWE Early Literacy Stations
	16 Online-Public-Access-Catalog (OPAC) stations
	8 self-checkout stations
	Seed library
	Culture Passes
	2 photocopying & scanning stations (not connected to a network)
	Polaris program to manage website and several research databases through the state library
Sunrise Mountain Library	Self-checkout stations
	The same Polaris program as the Peoria Main Library
	Indoor and outdoor play areas
	40 public computers with Microsoft Office and Adobe PDF Reader
	A nearby park
	Free public Wi-Fi
	Seed library
	Book drop-off service
	Natural lighting
	Modern design and layout
	75 seat meeting space
	50 seat story time room

Figure 25 *The Peoria Main Library features many useful assets, some of which could stand to be updated or improved. Sunrise Mountain Library appears to have fewer assets but a more pleasant indoor environment.*

Gap analysis

Peoria Main Library

Even though the Peoria Main Library offers many important and functional assets, the Library currently has some notable limitations, offering areas for improvement. The current state of Peoria Main Library includes:

- A remote parking lot
- Reduced safety during night hours
- Remote and inaccessible book drop off
- An outdated aesthetic
- Excessive separation between public spaces
- Gaps in lighting
- Problematic building acoustics
- Lack of small group spaces
- Lack of adequately sized employee spaces

Implementing the following ideas could improve some of the shortcomings of the library, leading to an increase in library activity and use satisfaction. The envisioned state for Peoria Main Library would include:

- More accessible parking for patrons
- Increased lighting to enhance safety at night
- Drive-up book drop
- A modern design update to better relate to surrounding buildings
- Establishment of more inclusive spaces
- Inclusion of LED lighting and more natural daylight
- Addition of an internal quiet room
- Addition of small group spaces and a larger room for staff members

Sunrise Mountain Library

Sunrise Mountain Library is also an important asset to the community, but has room for improvement, particularly in the design of its physical space. The current state of Sunrise Mountain Library includes:

- Limited book drop-off abilities
- An inconvenient, bottleneck lobby design
- Uncontrolled natural lighting, which can potentially cause problems
- Problematic acoustics
- Limited seating options
- Limited small group spaces
- Limited convenience power
- Lack of a hands-on learning environment
- Lack of an after-hours pick-up or drop-off window

Adjusting the library's physical space to be more accessible and facilitate diverse activities could expand the current user base and provide a pleasant experience for a wide variety of visitors. The envisioned state of Sunrise Mountain Library would include:

- Adding an accessible drive-through
- Changing the desk format in the lobby to facilitate more open space
- Tinted windows to reduce the natural lighting issue
- Adding an internal quiet room
- Using simple furnishings that can be easily moved
- Create more small group rooms
- Install more power outlets in convenient locations (e.g., on desks and near seating areas)
- Create multi-use learning areas
- Install a locker in the parking lot for after-hours book returns

Connectivity: Peoria Main Library SWOT analysis
Strengths
The public can check out **Sprint mobile hotspots,** bringing a wireless connection home for two weeks. **E-books and e-library services** provides the public with the ability to access library materials and services through an online platform (which could also be used alongside the mobile hotspot). The library provides **computer labs**, which encourages patrons to stay and use library services while having a definitive quiet space to work. **The Polaris website** provides public access to e-library services including Freegal Music, Rocket Language, practice driving tests, career preparation center, and the Peoria Library event schedule.
Weaknesses
Lack of space for group congregation impacts the amount of people who may visit the library. **Limited resources** including hands-on learning environments, Wi-Fi hotspots, the inability to check a hotspot out a second time, lack of a physically present language tutor, and lack of computer rental may limit patronage for a number of reasons. **Outdated decor** potentially decreases the amount of people using the library based on the environment. The two photocopying and scanning stations are **not connected to a network**, making it difficult for people to print their own items unless they bring a flash drive.
Opportunities
Creating more individual, sound proof, **group work spaces**, provide a larger opportunity for people to use the library as a gathering space. **Public computer rentals** would increase the technological connectivity people have with their library. More library **event advertising** could be beneficial. Membership perks could also be advertised, such as free use of Microsoft Office programs and e-cards. Since all resume and career building resources are only offered online, it could be helpful to have a **resident expert** available in person at the library to assist with resume building. **Updating the interior** of the library (which is currently in the works for 2020), could lead to higher patronage. **Connecting** the photocopying and scanning machines to the internet would be beneficial.
Threats
Public behavior has changed and many people no longer take reading as a serious hobby. Teenagers don't attend libraries in droves because they associate them with an older crowd and feel they are outdated. **Lack of awareness** around the resources libraries have to offer can cause low patronage. **Parking** is not well connected to the library, and the outdoor lighting situation would benefit from an upgrade.

Connectivity: Sunrise Mountain Library SWOT analysis
Strengths
Everything mentioned in the Peoria Main Library strength section applies to Sunrise Mountain Library, in addition to the following two points: The Sunrise Mountain Library has a more **modern layout** with movable seating arrangements and a prime location. Sunrise Mountain Library is also **conveniently located** across the street from a park and has both indoor and outdoor play areas for children. The Sunrise Mountain Library provides public **outdoor spaces** as well as closer parking and a book dropoff.
Weaknesses
The building **does not facilitate group interaction** or noise reduction. Separation from loud group events may be difficult for visitors seeking a calm work environment. There are **limited charging stations** that do not support guest demand. Patrons may worry about a **lack of privacy** on public Wi-Fi.
Opportunities
Implement more **group spaces** and reduce noise pollution throughout the building. **Extend hours** on the weekend to accommodate more guests. Establishing a **checkout process** for computers and free Microsoft Office programs for members would be incredibly helpful. Adding **charging stations** is important if Sunrise Mountain Library wants to increase technological connectivity so patrons can charge their devices and stay longer.
Threats
The same threats mentioned in the Peoria Main Library portion also apply to Sunrise Mountain Library except for its location (as Sunrise Mountain Library is in a convenient location).

Library accessibility SWOT analysis
Strengths
The library **accommodates people** of all different abilities though collections that circulate video materials, e-books, and the largest number of audio materials between both libraries. **Electronic tools** like the Libby App facilitate remote access of library materials and boosts the library's e-circulation. E-circulation includes a language-learning program (Rocket Languages) and a music library (Freegal Music). The library has good **computer accessibility**, with adult and youth-specific labs as well as Wi-Fi hotspots. The library is **physically accessible**, with many parking spaces, ramps to enter the library, and a drive-up book drop-off. The library is also centrally located near City Hall, allowing accessibility for more potential patrons.
Weaknesses
The popularity of **e-circulation** results in low physical circulation, meaning there is less interest in library materials and less patronage overall. **Low foot traffic** has caused Peoria Main Library to reduce the number of available computers. There is also noted trouble engaging with the teen demographic.
Opportunities
With these threats come the opportunity to **expand library use and purpose,** expanding capacity to serve as central community spaces. This means making the library fully accessible to all community members so more see it as a point of reference. **Accessibility for disabled persons** is sometimes considered insignificant and may not be prioritized. The Peoria Main Library's extensive collection of audio and visual materials can be changed to consider those with aural and visual disabilities by integrating Braille into the spines of audio material cases. **An afterhours book retrieval system** may make it easier for disabled patrons to return books on time.
Threats
Scope of improvements can be difficult to narrow down. Not everyone can be accommodated all the time, so the solution is to ensure implementations are adjustable and have a mechanism for community comment.

Recommendations

Connectivity

- Provide an after-school shuttle from nearby k-12 schools to the library, which could potentially foster an organized after-school program. This would increase the amount of people visiting the library and could potentially increase the number of teenagers that attend.
- Utilize the online scheduling platform to allow people to search for and sign up online for events. It may also be beneficial if patrons can use the website to check out Explore-To-Go kits and Culture Passes.
- Incorporate a teen space with different gaming consoles and high-speed computers such as MacBooks to promote more involvement with the teenage community.
- Provide movable furniture to allow patrons the freedom to create custom workspaces. Adding more group spaces and accessible charging stations may also improve the workspace experience.
- *Consider installing helpful technologies such as bulk separators, laptop and tablet kiosks, and interactive multi-touch tables to enhance library experiences for guests and employees (Napolitano et al., pp. 4-5).*
- *Upgrade the libraries' main web platform to Polaris Leap, allowing for automatic updates, a modern interface, and web browser flexibility (Napolitano et al., p.6).*

Accessibility

- Implement more assistive technology, which refers to generalized technology that helps people with processing.
    - Assistive technology for visual materials can include screen-reading and magnification technology through closed-circuit television (CCTV), Braille translation software, and portable magnification devices for books. Web services like ZoomText and Job Access With Speech (JAWS) are also widely used.
    - Assistive technology for audio materials can include assistive listening devices, automatic captioning features, and small amplifiers. Hearing loops are also popular for transmitting announcements amidst ambient noise.
        - Hearing loops technology simply requires feeding the sound through an amplifier, which then transmits through wires in the ceiling, which can then be picked up by hearing aids and cochlear implants.
    - Establish a library hotline for curbside pickup to allow patrons to call or text librarians for certain books in the event of a mobility flare. This also accommodates aural impairments.
- Conduct additional surveys specifically centered on accessibility and connectivity to determine which specific technologies Peoria residents may find useful.
- *Develop a long-term plan to build a smart library of e-books, available to checkout online, to better serve patrons that otherwise may not be capable of physically visiting a library (Napolitano et al., p.6).*

CONCLUSION

Peoria's desire to build on its unique character within the West Valley and move toward becoming a Smart City is indicative of the creative spirit it has exhibited since its founding in 1886. While there are many steps necessary to become a Smart City, this report clearly indicates that Peoria already has the key ingredients of a capable workforce and a demonstrated desire to enhance the City through technological innovations.

To continue the process of becoming fully integrated as a Smart City, students suggest focusing on key areas of improvement that are considered both high-impact and feasible. Enhancing police and fire services with emerging technologies can increase community safety as well as employee safety. Iconic public spaces such as the P83 entertainment district can improve on its visitor experience by implementing smart amenities. Lastly, public spaces like parks and libraries can potentially expand their user base while enhancing current user experience through technological improvements.

The close collaboration between the SOS 498/594 and BUS 593/SEC 598 classes aimed to assist the City of Peoria with developing its framework to become a Smart City. Students suggest focusing on building the necessary evaluation processes, dedicating the necessary financial resources, and crafting a clearly articulated vision for the City. By implementing the short- and long-term goals outlined within this report, the students believe Peoria can easily become Arizona's premier Smart City within the next 5 years.

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To access the original student work, including student papers from both the BUS 593/SEC 598 Interdisciplinary Applied Learning Lab, and SOS 498/594 Urban Sustainability Best Practices class, visit:

links.asu.edu/PCPeoriaSmartCities19F

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Figure 24 Tablet dispensing kiosk at the Austin Public Library, by Mike Russell via Wikimedia Commons
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