

6-16-2021

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Sequoia G. Bellanca  
*Portland State University*

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## Recommended Citation

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<https://doi.org/10.15760/honors.1088>

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Disaster and the Built Environment: How the PREPhub has the potential to impact preparedness  
and create resilience during natural disasters.

By  
Sequoia Bellanca

An undergraduate honors thesis submitted in partial fulfillment of the requirements for the  
degree of  
Bachelor of Science  
in  
University Honors  
and  
Public Health Studies: Clinical Health Sciences

Thesis Advisor

Richard Dozal-Lockwood Ph.D., MPH

Portland State University

2021

### **Abstract**

Around the world, natural disasters pose a common threat to most communities. In 2015, Thecho, Nepal, suffered a magnitude 7.8 earthquake, killing 9,000 people and injuring nearly 22,000 (Reid, 2018). In the Pacific Northwest, the coast awaits a catastrophic earthquake, known as “The Really Big One” (Schulz, 2020), scientifically predicted to cause mass destruction. Although communities continue to experience and anticipate these disasters, the preparedness rate amongst individuals is shockingly low. Using this information, researchers developed a structure, rooted in interdisciplinary design, that will aid in the passive education of disaster preparedness amongst individuals and communities. Through unobtrusive qualitative research, information drawn from peer-reviewed and web-based materials was collected using the record-keeping method. Using a journalistic approach during this investigative process, this paper looks at the potential of the prototype structure, known as the PREPhub, in two communities and its relation to the public space, health, and built environment. While the Nepalese community already has an established structure, this paper advocates for implementing the PREPhub on Portland State University’s campus to prepare students for disaster.

*Keywords:* disaster, preparedness, public space, health, built environment

## Introduction

While the world holds diverse cultures and geographic landscapes, there are unified experiences that bind us together. One of these experiences is the ongoing threat and effect of natural disasters, especially as climate change increasingly creates disruptions around the world. In 2019, the total number of global natural disasters reached 820, resulting in roughly 9,000 fatalities (III, 2020). According to a report from 2016 on the most frequent disasters recorded over a decade, earthquakes came in third, second to storms and flooding (Myers, 2016). Due to the makeup of the earth's crust, few areas enjoy the low probability of facing the wrath of these geophysical disasters. Six years ago, Nepal's Kathmandu Valley faced a catastrophic earthquake that produced an extensive loss of life and property (Sharma, 2015). Currently, the Pacific Northwest of North America anticipates the destruction of most of the western coast by a catastrophic earthquake, the "Really Big One" (Schulz, 2020).

In a world plagued by disasters, there are lessons to be learned from previous catastrophes. One of these lessons is that people are not optimally prepared for natural disasters. In Sweden, a survey of nearly 1,000 people documented the preparation levels of residents, ages 16 - 74, in the event of a disaster. The least amount of preparation among individuals was their involvement in training programs and organizations. The most considerable amount of preparation was installing smoke alarms, practicing safety procedures at work or school, and being certified in first aid. Even more, researchers concluded that emergency preparedness by individuals was not better due to a sense of uncertainty of what they should prepare for, and instead, they concluded that being prepared in front of family and friends was perceived to be embarrassing (Larsson & Enander, 1997). Additionally, it is estimated by the Federal Emergency Management Agency that 60% of Americans have no emergency plan during a disaster. Dr. Anthony Masys of the

University of South Florida College of Public Health attributes this high number to “our skewed perception of risk and tolerance for its potential consequence,” meaning that Americans often think of the disaster as less severe when cautiously reported or that the reports are too historically inaccurate to prepare (Campisano, 2018).

With an apparent failure in preparation among the world's communities, researchers in various disciplines pursued strategies to address the neglect of health and safety protocols. Solutions to poor disaster preparedness can benefit from multidisciplinary work as they require flexibility and varying points of view on the complexities of disaster situations. The “mobilization to prepare, respond, and recover effectively from major disasters requires a full-scale collaborative and multidisciplinary agenda to integrate ways of understanding and changing the dynamics of resilience from molecules, microbes, and microchips to cities, societies, economies, electronic communities, and ecosystems” (Masten & Obradović, 2008).

With the work of the architecture, urban planning, and public space sectors, a specialized structure was recently developed to aid in the passive preparation of community members in case of disaster. This paper will review the development of the structure, its international implementation, and its potential impact on the Portland State University community while also examining its use of public space in the built environment as an instrument in its preparedness method.

### **Background**

Among the researchers investigating and inventing solutions for emergency preparedness, colleagues at the Massachusetts Institute of Technology (MIT) developed a specialized structure for public spaces that serve the community. This innovative structure, called the PREPhub,

formally known as the Emergency Preparedness Hub, is designed to attract engagement by community members and passively educate the public about emergency preparedness methods.

This research was initially conceived as a systematic review of the literature, however, the prototype PRPEhub structure was built in 2016 and due to its recency, peer-reviewed literature on the object does not yet exist. Thus, it was impossible to determine the effectiveness of the hub in a disaster situation and success in its community based on peer-reviewed research and evidence. From the lack of sources and upon further investigation, it was discovered that the PREPhub is still in its prototype phase. Currently, there are only two functioning PREPhubs globally, and two other hubs are in the process of implementation in urban American cities.

To continue the investigation into the PREPhub and its relevance in the emergency preparedness and resilience discourse community, a different tactic was employed. Remaining within the domain of unobtrusive research, the investigation focused on the importance of the built environment for improving disaster response. Two disaster-prone locations are examined.

### **Methodology**

With limited data available on the effects of the PREPhub, a qualitative approach was employed to uncover the potential of the hub in at-risk environments. Using a journalistic lens during this investigative process involved the search for various materials and freely available artifacts regarding natural disasters, preparedness, at-risk communities, the built environment, and the structure itself. Within the field of qualitative research, record-keeping methods were utilized during the search for existing documents and sources found through extensive and reliable internet and database searches. When searching for these materials, peer-reviewed journals containing facts and relevant information were prioritized as well as peer-reviewed documents that contained information regarding the feedback of various community members

through focus groups and survey reports. In addition to these scholarly sources, reliable web sources were used in support of facts and descriptive backgrounds. These existing materials were compiled, analyzed, and appropriately integrated into their sections to construct a central theme. With a wide range of sources from various disciplines, the use of these materials constituted an analytical framework for assessing the passive preparedness and potential benefit of the PREPhub.

### **MIT PREPhub**

In this chapter, the development of a specific emergency preparedness infrastructure, known as the PREPhub, and its purpose, is discussed. Along with this discussion is an introduction to MIT's Urban Risk Lab (URL), and the researchers contributing to the infrastructure's development. With the continuing threat of natural disasters, researchers in the lab have worked to find solutions rooted in emergency resilience and preparedness, in order to protect vulnerable populations. The URL has developed an infrastructure that contributes to the discourse on emergency preparedness and holds the potential to positively affect disaster resilience positively.

At MIT, many researchers work on interdisciplinary projects within its Urban Risk Lab. Within the lab, projects are dedicated to reducing the risk of emergencies and increasing community resilience through technology that meshes with specific communities. As a collaborative research community, the lab works globally to assess various rural and urban scale risks. Their goal is to "proactively embed preparedness and risk reduction in this rapidly urbanizing world" (MIT Urban Risk Lab, 2021). Working to meet this goal, a team of URL researchers developed the concept and implemented the design and structure of the PREPhub.

Among the PREPhub team members is Miho Mazereeuw, the director of the Urban Risk Lab. After graduating from Wesleyan University with a Bachelor of Arts in Sculpture and

Environmental Science, she continued as a student at the Harvard Graduate School of Design, mastering in Architecture and Landscape Architecture, earning various awards for her academic achievements. As a current landscape architect and associate professor of architecture and urbanism at MIT, she works on disaster resilience in urban, public spaces and is specifically working with countries like Haiti, India, Japan, and Chile (MITdesignX, 2020).

Lab Research scientist Aditya Barve received his Bachelor's in Architecture from the University of Pune and his Master of Science in Architecture from MIT. Similar to Mazereeuw, his studies focus on resilience and preparedness in urban environments, specifically Nepal and India (MITdesignX, 2020). As two major leaders within the URL, and working on the PREPhub, Mazereeuw and Barve will be the lab members highlighted in this discussion though they were supported by many members.

In 2016, the URL identified a gap in emergency preparedness solutions in response to natural disasters within at-risk communities both in the United States and globally. Using their backgrounds in architecture, city planning, and design, the team developed structures, called PREPhubs, that are uniquely designed to coexist with city planning and fit culturally into the context of their ultimate locations – urban or rural. Using the interdisciplinary backgrounds of the team, these structures were meant to serve multiple purposes that involve daily or emergency services, while being visually appealing in their specific environment.

According to Mazereeuw & Yarina (2017), the PREPhubs are designed to be perceived as sculptures on a daily basis, offering unique designs to the landscape, while also aiming to establish a communal gathering space with the presence of power for charging ports for electronic devices, information, and seating. In addition to these services, the hubs will have functions unique to disaster preparedness. They plan to have the potential to collect and store



solar energy to supply emergency power for communication devices, emergency tools & supplies, and are connected to emergency services. The intended purpose of PREPhubs in a natural disaster is to provide an assembly place for community residents for the receipt of basic first aid, water resources, and energy via generators through solar or pedal-powered energy while awaiting the support of emergency services. When focusing on the design of the PREPhubs, the team made the infrastructure customizable to its location in any environment. These adaptable structures can vary in size to include some as small as sidewalk models to those that can fill a large civic plaza. Despite a difference in size, the PREPhub is designed to be enabled with various functions at each site that serve both daily and emergency needs.

When researchers designed these hubs, they prioritized basic activities that would promote community gathering. By making these structures approachable by advertising the daily features and placing them in a location for frequent use, there is an increased level of engagement with the community. After years of research, dating back to 1995 after an earthquake in Kobe, Japan, the URL deduced that an effective way of enforcing emergency preparedness was by inserting it into the everyday life of the community (*Prephub*, 2016). In related research, globally focused studies report that large populations are left vulnerable to the risk of disasters due to low preparation rates of residents. Using similar information, the team designed the PREPhub to attract many people for everyday use, to increase the rate of exposure and familiarity with the area, environment, and services of the hub. During a disaster situation, the aim is for the community to know where to gather and how to use the services automatically. The goal is to improve emergency preparedness and disaster resilience among community members, while also reducing mortality due to disasters.

With research to support the PREPhubs' potential as a successful infrastructure, set to reduce risk in case of a natural disaster, the lab has installed working models. While a fully functioning PREPhub can be found on MIT's campus, the lab has broadened its program to consider the impacts of PREPhubs and has placed one in an at-risk community in need of disaster relief aid. A model can be found in Thecho, Nepal, an area prone to disastrous earthquakes. While the Urban Risk Lab has focused its expansion abroad, they are also finding areas in the United States that would benefit from a structure dedicated to emergency preparedness.

### **Nepal PREPhub**

In this section, the indications for intervention in emergency preparedness in Nepal, as well as its specialized PREPhub will be discussed. The PREPhub design discussed above has a modern design that would not fit well in every context. The URL has a process for assessing the appropriateness of cultural fit for proposed designs as they are considered for a specific destination. Using this process, the URL determined that they must adapt the design for use in Nepal. Below, the importance of variable functions based on environment and its effect on its engagement with the public is stressed and shows support for the structure's custom implementation in different at-risk environments for emergency preparedness and disaster resilience.

In 2015, the Nepalese Kathmandu Valley was struck by two major earthquakes. On April 25, a magnitude 7.8 earthquake hit Nepal, causing massive loss of human life, destruction of buildings, and released landslides and avalanches in the Himalayan Mountains. During the initial shock, nearly 9,000 people died, and 22,000 experienced injuries. It was reported to be Nepal's deadliest earthquake in nearly 100 years. Shortly after, during Nepal's recovery period, the region received hundreds of aftershocks before experiencing the second, major magnitude 7.3

earthquake. The loss of housing and community buildings was devastating, with nearly a combined 888,000 homes either damaged or destroyed in the areas that were worst hit. Much of the damage and the strongest effect of the earthquake occurred in the rural, remote areas of Nepal, making recovery and aid even more challenging (Reid, 2018).

Following the disaster, the magnitude of mortality and destruction attracted researchers from the URL. Nepal was identified as a region with limited time for an intervention. Researchers in disaster resilience have stated that areas with open space are the best places to stay safe during an earthquake, reducing the chance of being affected by falling debris. However, Nepal faces one of the highest growing population rates in Asia, experiencing rapid urbanization and a decrease in open space (MIT Tata Center, 2018). With overpopulation in a dangerous region, and the likelihood of future seismic events, researchers recognized that they should assess available open spaces for site locations.

Researching the Kathmandu Valley proved difficult due to the political environment and lack of elected officials during the period after the earthquake. When deciding the location for their intervention, researchers collaborated with community groups including those in government, non-government, local, and international to complete their ethnographic mapping of the region (Mazereeuw et al., 2020). While mapping, the community expressed their dire need for a clean water source, both during everyday use and post-disaster. Not only was clean water a necessity, but access to water aided in their post-disaster resilience when they were unable to return to their unstable homes, or other wells in their area were damaged from the quake. A needs assessment with community partners identified a location with a lack of clean water sources. This strongly influenced the selection of the site because the PREPhub provides reliable, clean water. (Mazereeuw et al., 2020).

While these researchers were integral to the PREPhubs implementation, community groups helped tremendously. One group, the ENPHO: Environment & Public Health Organization, aided in conducting tests of water quality and the other, Lumanti Support Group for Shelter, established committee groups within the Thecho Women's Cooperative. The committees allowed for communication of needs between researchers and the prospective communities, learning about needs and expectations of the aid to be received (Mazereeuw et al., 2020). After extensive ethnographic mapping of Nepalese land and local collaboration, the researchers decided to install their hub in the village of Thecho.

After identifying the target area for the PREPhub, researchers focused on an appropriate design for the structure. The domestic PREPhub prototype, designed to blend into a metropolitan environment, with a sleek and unique design did not fit the cultural climate of the Thecho community. Along with the community partners, designers on the project identified an ancient, culturally significant structure made exclusively for community use. A place for gathering, and shelter, structures called *paati's*, with their *dabali* extension for a performance space, were selected to serve as the model for a culturally appropriate PREPhub (Magee et al., 2016, p. 21). *Paati's* are redundant structures found throughout Nepalese villages. Dating centuries of years old, they originally served as rest spots for travelers between villages on ancient trade routes. While they are common, many are damaged due to past damage, use, and age. The URL researchers were able to carry out public health aid successfully in this area because of their ethical engagement and communication with the community. By adjusting the design to better fit the environment, the PREPhub *paati* could continue its ancient functions, while also adopting modern ones. While it serves as a gathering spot today for various reasons, the PREPhub honors the *paati's* historical function of serving as a public space for the community.

Taking inspiration, the researchers and designers, along with local builders reconstructed a destroyed *paati* and made it strong enough to withstand damage from a potentially seismic event, or another pending disaster, with concrete, steel, and bricks (Mazereeuw et al., 2020). Similar to the purpose of the prototype PREPhub in its design, the *paati* is maintained and used by the community members for various purposes. As the structure of this building is open-air, a common use is seeking shade or protection from the elements, or a place to rest. Community notices and information are posted in these areas, and religious, social, and community meetings are held within the building frequently. In addition, it actively serves as a homeless shelter and is maintained and monitored by the community (Magee et al., 2016, p. 212). The three major additions to the *paati* have increased community engagement due to the limited resources of each. The *paati* now has public lighting that allows the public to remain after dark, a power bank to charge phones, and freshwater (Mazereeuw et al., 2020).

For researchers, and the local community partners, specifically the Thecho Women's Cooperative, the water storage tank, spout, and filtration system were a high priority in the PREPhubs implementation. This function determined its placement. With contaminated water sources near, and safe water far away, the presence of the water at the *paati* greatly increased its use among the public, but especially the women who were tasked with retrieving it for their households (Mazereeuw et al., 2020). In addition to these important features, a compartment underneath the floor holds rescue materials and first aid supplies. Similar to the hub design based in America, the purpose of the hub in Nepal is to provide shelter and emergency supplies during and after an earthquake and familiarize the public with these services through daily interaction. As an established meeting place, with light, power, and water, any of the interacting public would be familiar with the location of the *paati* and recognize it as a safe zone during a disaster.

During an earthquake, the protocol is to move away from buildings and into the open. By implementing the PREPhub in a public, open space people can safely access aid and shelter.

After its implementation by URL researchers and designers in 2018, the management of the *paati* PREPhub was transferred to the Thecho Women's Cooperative. Since the catastrophic events of 2015, Nepal has not experienced a similar devastating disaster to justify the complete emergency use of the hub. However, the continued use of the community space for water, meetings, shelter, and power keeps the public engaged with its features and aware of its presence (Mazereeuw et al., 2020). Similar to the hubs in America, the goal of these structures is to passively educate the public through continued use of its features, and familiarizing themselves with the hub. Unlike the American hub, the designers and researchers in Nepal took extra factors into account for the location, features, and design of the hub. While the hub based in America has a sleek, modern design, and supplies, it does not have specialized resources that are unique to its location, like the water system in Nepal's *paati* PREPhub. When researchers addressed a dire need in the community, it increased the engagement of the PREPhub, allowing more people to frequent the structure and understand its use through interaction (Mazereeuw et al., 2020). The success of this custom resource can be useful moving forward while considering the future of the PREPhub in a variety of environments. In North America, much of the western coast awaits a catastrophic earthquake and has the potential to experience smaller quakes until then. As demonstrated by the work in Nepal and the original American structure, the *paati* and modern structures can serve as a model to uniquely provide passive health education to the public while addressing various custom community needs.

### **Portland State University PREPhub**

In this section, the PREPhubs installation in response to the Pacific Northwest's impending disaster, and the conversation amongst Portland community members are discussed. The purpose of this section is to serve as both a form of advocacy for the PREPhub's potential, as well as cautionary for the members of the community during a time when disaster is imminent.

Within Portland State's Honors College, the previously named Portland General Electric (PGE) Sustainability Scholarship was awarded to students with an interest in urban sustainability and the development of smart city projects. Shortly after beginning my freshman year, I was selected for a scholarship in October 2017 and have served as a Sustainability Scholar for the past four years. In partnership with PGE, the goal is for students to design and implement sustainable and intradisciplinary projects in the city. Along with PGE, PSU, MIT, and the City of Portland, one project was a direct result of a partnership with the Urban Risk Lab.

The Pacific Northwest has been the pending target of a catastrophic earthquake for years, with an unknown disaster date. The Cascadia Subduction Zone, beginning in Northern California and spanning 700 miles through Vancouver Island, Canada, presents a threat that could take out the entire region of the Pacific Northwest. In this subduction zone, the Juan de Fuca plate slides under the North American plate. The predicted magnitude of the Really Big One is 8.0-9.2 on the Richter Scale. . When this disaster occurs, Portland, Seattle, and other cities comprising nearly 7 million people will be directly affected by the earthquake (Schulz, 2020). The figured aftermath of the disaster is comparable to disastrous earthquakes seen in Southwestern Japan and Chile, which have both experienced immense damage (Heaton & Hartzell, 1987).

With an unknown disaster date and millions at risk, preparedness must be a priority amongst individuals and the community. However, research has shown that local communities remain

unprepared. According to survey results from residents of the Portland Metropolitan Area, only half of the 101 residents surveyed said that in case of disaster, they would be prepared enough to handle themselves and their families. The remaining 50% reported they were not prepared with the reasoning of a “lack of concern” for the impending disaster (Shannon, 2019). This dangerous reasoning is a common response from the unprepared. Even people who do report preparedness, often do not realize how they both overestimate their ability to respond, and how they jeopardize their safety due to this overestimation (Donahue, Eckel, & Wilson, 2013).

In 2016, the URL selected Portland as the location for a PREPhub as part of their pilot program, due to the PNW’s status as a prolonged at-risk area. Survey results, such as the ones cited above, provided the framework for researchers to focus on the Portland community, reasoning that if people will not prepare themselves then the structures will. Through this model, PrepHub’s have the opportunity to become a form of public health practice that addresses issues as “specialized functions,” (Rose, et al., 2017), and provide the opportunity for a major impact on the reduction of community disaster risk and harm (Redwood-Campbell & Abrahams, 2011). In addition to the lack of preparedness of the general public, many college students fail to prepare themselves while living and working on campus. During a focus group conducted by Davis et al., in 2019, students communicated that there was a lack of preparedness for natural disasters amongst themselves and their peers. The group leaders concluded that:

students tend to perceive the university as a place of safety removed from the possibility of a disaster...[and] if students have an overly strong sense of safety such that they do not consider the potential threat of a disaster, then preparedness efforts may be less of a priority than other responsibilities and activities...In addition, university students had



little knowledge about what to do in the event of a disaster, and most said they did not have access to disaster preparedness materials. (p. 40)

When examining Portland State's emergency earthquake protocols, most of the instructions and additional resources direct those affiliated with PSU to research preparedness strategies independently, leaving students and staff to learn preparedness on their own. As referenced above, it is reported that Portland Metropolitan area residents reported that only half the population prepares themselves, and many college students assume they are in no danger and disregard potential risk. Although PSU has Emergency Access Guides, little information about natural disaster preparedness and protocol is provided (*Emergency Management | Portland State University*, 2021). On the PSU site *What to Do in Case of an Earthquake*, directions are posted for steps to take in case of an earthquake in certain situations, including if an individual is indoors or outdoors. However, it offers no resources for supplies, power, or first aid, which are critical when facing the aftermath of a major disaster (*Earthquakes | Portland State University*, 2021).

### **Public Space in the Built Environment**

The City of Portland, and a small area of PSU, does however have an earthquake preparedness strategy and protocol already in place. Throughout Portland, Basic Earthquake Emergency Communication Node lockers, or BEECNs, are placed at 50 different sites and serve as a temporary radio communication device if phone service is down. Their purpose is to serve as an immediate reporting device in case of damage or injury (*BEECN | The City of Portland, Oregon*, 2021) and is operational 24-48 hours after a major earthquake (*Frequently Asked Questions about BEECNs*, 2021), but they do not operate at night (Tufté & Palleroni, 2021, p. 21). The closest one to the PSU campus is located on SW 12th and SW Market (*Find a BEECN*

*Site near You*, 2019). During the aftermath of a major earthquake, these sites are operated by volunteers of the community. While these can operate as an emergency tool, they do little to prepare the community about preparedness methods or safety post-disaster. These lockers are discrete and do not engage the public, with most community members unaware of their neighborhood presence (Tufté & Palleroni, 2021, p. 3). In addition to the lack of presence, these lockers are limited in their functions and their operations heavily rely upon volunteer guidance, which can become unreliable when experiencing a disaster.

While many issues involving the BEECN lockers should not be ignored, the issue of public space is important to discuss. Where the BEECN and other emergency preparedness methods lack, the PREPhub excels. The purpose of the hub is to have a public, community presence to encourage engagement through its daily functions and services. Through the engagement comes familiarity with the structure's location, features, and purpose through the passive encounter with the disaster relief side of the hub. In 2018, Carmona et al. discuss that when developing meaningful public spaces:

over time, spaces become more meaningful as users interact with them and they acquire the patina of age and use. Spaces can also become more meaningful by...hosting other amenities and features with which users can directly engage...equally they may be restful, serious or contemplative, such as public art, sculpture furniture memorials and monuments, reflection pools, flower gardens/displays, wifi hotspots, and so on. (p.54)

The concept of a meaningful space is deeply ingrained in the development of built environments. The built environment is a concept referring to the man-made structures, from small features to large cities, known as built forms. In 1990, Lawrence & Low defined built forms as:

building types (such as dwellings, temples, or meeting houses) created by humans to shelter, define, and protect activity...[they] also include, however, spaces that are defined and bounded, but not necessarily enclosed, such as uncovered areas in a compound, a plaza, or a street [and] they may include landmarks or sites such as shrines, which do not necessarily shelter or enclose activity. (p. 454)

Of the structures discussed, all can be considered part of the built environment. However, the use of public space in tandem with these built forms determines their success in the event of a natural disaster. As mentioned above, the BEECN has limited functions to aid communities post-disaster, and it has no community presence. In contrast, the PREPhub design, instilled in Nepal and designed for PSU implementation offers services pre-and post-disaster that includes many of the features that define “built forms.” With these forms and the use of public space for engagement, the connection to the community is both impactful and meaningful. Following the observations of these structures, and the impact of other disasters it is noted that the built environment “is a critical physical variable of community resilience against disaster” (Wang et al., 2017).

Following the Wenchuan Earthquake in 2008, researchers studied how the role of the built environment can impact the resilience of a community to natural disasters. Through their observations of the devastating aftermath, they discovered that the built environment can either save or destroy a community post-disaster. Researchers of the Wenchuan Earthquake described the scenario of the disaster and its aftermath as a multi-environment related issue. In order to create resilience to the disaster, the environments need to impact each other most effectively. “The natural environment is the resource base of the built environment with buildings and infrastructure that provides functional support for human society” (Wang et al., 2017). With the

intended disaster representing the natural environment, the PREPhub, in this case, would be the built form providing support for the community. Following lessons learned from the Wenchuan Earthquake, the built environment directly impacts human society. If the interaction between the built form and the community is poor, there would be little awareness about precautions or preparedness, leading the built form to fail and allowing the disaster of the natural environment to have a maximal effect. The first step in using the built environment for resilience is planning land use by “identifying and assessing local natural hazards; dividing lands into suitable, feasible, and hazardous areas; and optimizing the planning of the built environment” (Wang et al., 2017).

### **Selection of Space**

In February of 2019, during the Portland Winter Lights Festival, PSU’s Center for Public Interest Design introduced the concept of a PREPhub through an information board located near the hub’s possible placement. Containing information about the design and purpose of the PREPhub, space was also provided for community members to write their reactions to proposed questions. Following each night of the festival, community responses to the proposed PREPhub were recorded for review. Additionally, stakeholders were invited to a community charette where suggestions, insights, and concerning issues were shared, producing extensive and constructive dialogue about a PREPhub placement on campus.

The PREPhub’s intended location, the Oak Savanna, is a 1.1-acre open space home to native Oregonian plants and wildlife, and currently functions as an outdoor learning space as well as a staging area for construction. The URL chose this site due to its proximity to both the campus and residential communities of the Park Blocks and downtown Portland. While it has experienced many uses, the indigenous community at PSU hopes to reclaim this space as a true

Oak Savanna. With an ancestral history as caretakers, including the clearing of the land by fire before the arrival of European settlers (State University of New York at Geneseo, 2019), local indigenous people like faculty member Judy Bluehorse-Skelton, as well as the Native American Student & Community Center, hope to restore the space by preserving it and renovating nearby spaces to promote the education of “bioregional history, ecological systems, and lifeways of indigenous peoples” (Tufte & Palleroni, 2021, p. 8).

During the charette with community members and stakeholders for the proposed PREPhub, it was reported that the native significance of the cultural space influenced the conversation amongst stakeholders. Despite initial plans for developing the Oak Savanna into an outdoor-friendly environment featuring renovated buildings, a boardwalk, and outdoor classrooms among other plans for the area (Community Planning Office et al., 2019, p. 32-34), many of the community members and stakeholders noted that the development of the hub would need to pay tribute to the indigenous significance of the land. While not known by attendees during the PSU PREPhub charette, it would be important to note that the planning process happening simultaneously for the Nepalese hub was guided by respect and the desire to blend the PREPhub design with the culture of the native community in Nepal.

With cultural responsiveness in mind, many stakeholders expressed hesitation to approve a PREPhub on ancestral land, they noted it would also be a good space to lead informational sessions about the native life in the Oak Savanna, as well as native resources, and promote appreciation for the land and the opportunity to create a public space (Tufte & Palleroni, 2021, p. 19). In addition to leading informational sessions about the wildlife, they suggested giving informational talks about the BEECN lockers, hoping these two methods of preparedness could work together. Lastly, it was proposed that the structure could serve as an outdoor classroom area

for students, which would further introduce the students to the hub and encourage the use of the structure as a public space outside of learning, and increase interaction between the students of PSU and the hub's functions (Tufte & Palleroni, 2021, p. 18).

While the future of the Oak Savanna is uncertain due to the overwhelming interest of many groups, this land serves as a prime example of open space in an urban environment. In the event of a catastrophic earthquake, the protocol is to find an open area and to be outside, if possible. In the urban, downtown city of Portland, where few areas of open, public space are available, and tall buildings create urban density, the risk for destruction is high. PREPhub placement in the Oak Savanna would allow residents of downtown Portland and affiliates of Portland State University to evacuate to a safe location, while also having access to the hub and its services.

### **PREPhub Walkthrough**

To understand the purpose of the PREPhub as a built form, supporting the preparedness effort against the natural environment, a walkthrough is necessary to demonstrate its intended use for human society.

1. Public interacts with hub during non-disaster times. The public interacts with hub features including a charging port, neighborhood map, and entertainment information while it serves as a preparatory structure and urban sculpture. The exposure and use of structure in everyday life familiarize the public with its locations and functions.
2. When an earthquake occurs, the hub's disaster mode is activated. When activated, the hub highlights its disaster features. The hub now displays solar-powered energy, a backup pedal-powered generator, a horn, basic first aid, a light beacon, information display via a screen, and the neighborhood assets map converts into a map with emergency plans and routes. Additionally, there is emergency lighting, radio, and video communication.

3. Having been familiar with its location and features through exposure and interaction, the public congregates at the open-spaced hub before, during, and after the disaster. The open space allows for safety from falling debris, and the features of the hub allow communication, first aid, and power until extensive emergency services can assist and professional recovery can occur.

### **PREPhub Potential and Addressing Concerns**

While the PREPhub offers many benefits, community members in Portland shared concerns during the charette. One concern that was expressed was the likelihood of the PREPhub's technology being outdated before the PNW experiences “The Really Big One” (Schulz, 2020). In addition to this concern, many thought that updating this technology would be made more difficult by the anti-theft measures that would be implemented to the structure’s screens and exposed tech (Tufté & Palleroni, 2021, p. 22). While these are valid issues that should be taken into consideration during the process of implementation, a decision based on the most imminent need should be a priority. The Cascadia quake could happen anytime, whether it be within days, months, or years, but it is estimated to occur within the next 50 years (Schwalje, 2020). While there is a risk of the technology becoming obsolete, the bigger risk of unpreparedness could result in loss of life or serious injury.

Another concern was the PREPhub's proposed location being in an isolated part of the PSU campus. While the Oak Savanna is a prime open space, it is mostly trafficked by dorm residents, students in the surrounding classrooms and labs, and those associated with the athletic centers on the western side of campus. This location does allow for some exposure, but unless individuals travel that side of campus regularly, its presence is unknown to the general population of PSU. Some remedies for this issue include utilizing the hub as an outdoor classroom and installing

informational signage. If classrooms in the area conducted class outdoors at the hub, students who do not regularly frequent the west side of campus would gain familiarity and exposure to the structure. Additionally, other outdoor activities and programs could be held at the hub to engage the highest number of community members. Additionally, the use of signs can be used to direct students and PSU affiliates to the structure in times of passive use and response to the disaster. The use of signage in Seaside, Oregon warning of tsunami zones, and guiding individuals through evacuation routes educate passersby who are frequenting the area. If a tsunami alert was announced, individuals would be familiar with the routes to safety through their passive notice of the signs while they browse stores and enjoy the beach (KOIN 6 News Team, 2019). In Portland, the installation of signs around campus and near the structure would direct the unfamiliar towards the hub by either catering to their curiosity or helping to locate aid during the disaster. These possibilities would be key to addressing the concerns of ineffectiveness due to isolation, as “in situations where the occupants are unfamiliar with the environment, people rely heavily on the information from the signage to guide their navigation” (Chu et al., 2014).

While it was not a shared concern at the charette, a reasonable question to have about the structure is whether it can be used in other disaster situations besides earthquakes. The current PREPhub in Nepal was implemented with the primary goal of disaster preparedness and resilience against earthquakes. The PSU PREPhub also shares this primary goal. However, these structures are generally designed to assist in the preparedness for natural disasters, meaning they can offer their services in other situations. In 2020 and 2021, the West Coast experienced devastating climate storms. In 2020, California and Oregon experienced record-breaking wildfires that burned massive portions of land, “destroying thousands of homes and killing more than 30 people” (The Visual and Data Journalism Team, 2020). In 2021, the Northwest was hit



by a massive winter storm, receiving several inches of snow cutting power for tens of thousands of people (AP and OPB Staff, 2021). In these situations, the hub can be used in any weather environment (Kenoyer, 2018) and can be useful by offering its amenities like communication devices, solar or pedal generated power, first aid, water, and food to those affected. While the overflow of water from tsunamis and hurricanes may prevent access to the hub before, during, or directly after the disaster, the functions within the hub can be useful once the water recedes and land access becomes available again.

While the above demonstrates the PREPhub's potential in different situations, there are still issues with the implementation of the hub on Portland State's campus. As the COVID-19 pandemic impacted routine operations throughout the world, the implementation of the PREPhub on campus also came to a halt (Tufté & Palleroni, 2021, p. 5). This pause in planning increased the risk of unpreparedness in case of disaster, specifically amongst the PSU community. Public health can be defined as "the science of protecting and improving the health of people and their communities" (*What Is Public Health?* 2021). While the community continues to experience a global pandemic, it could additionally experience the public health issue of disaster unpreparedness that could also result in loss of life. With continued PREPhub planning and implementation a priority, achieving the goal of passive education of preparedness amongst students on campus can be met. As cited above, focus groups and surveys indicated that the majority of people do not prepare themselves for natural disasters. This structure works to passively educate its community to be ready for disaster and minimize the risk to life through the built environment, which is imperative in the safekeeping of the health of human society.

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