Fictitious Press Release

New A.I. Tool to Support Earthquake Safety Investment Prioritization for Schools in Developing Countries

In collaboration with the Cal Poly Digital Transformation Hub, the World Bank has created a new capability to enable developing countries to rapidly analyze building structural types and inventory school infrastructure to inform the prioritization of interventions and infrastructure investment.

News | WORLD – The Cal Poly Digital Transformation Hub (DxHub) powered by Amazon Web Services (AWS) collaborated with Cal Poly Professor Dr. Franz Kurfess and the World Bank's Global Program for Safer Schools (GPSS) to create a new analytics tool "AI for School Infrastructure Resilience" (AI4SIR). This tool empowers the rapid classification of existing school buildings' structural type in developing countries, at scale, to support seismic vulnerability assessment and inform the prioritization of infrastructure investments to efficiently mitigate the human and school infrastructure risk of potential earthquakes. This saves governments money on inspections and precious time to mitigate the loss of life. The new AI4SIR tool allows local, non-technical individuals to collect photographs and inventory the structural types of their specific school buildings. These photos are uploaded to a cloud-based algorithm that determines the building category, height range, and main structural system, allowing a trained engineer to review remotely for accuracy. From there, the data is aggregated and provided to planners and decision makers to prioritize disaster risk-reduction investments.

Schools in developing countries currently operate with poorly designed/constructed legacy school building infrastructure. This infrastructure represents a long-term threat to community safety when earthquakes strike. The World Bank works with representatives of developing countries to improve the process of efficiently prioritizing risk-reduction investments. This is done through the identification of representative structural building types and vulnerability assessments. With a rigorous technical base, this prioritization quantifies risk by assessing vulnerability at scale based on representative structural types and hazard maps, in order to optimize safety improvements from intervention investment.

The necessary foundation for conducting such a prioritization is a school infrastructure baseline to classify representative structural types. However, in developing countries such a baseline inventory with the requisite structural information is commonly unavailable or incomplete. Gathering necessary baseline information is a time-consuming and expensive task, requiring the mobilization of experts to inspect and document school infrastructure in remote areas. The process can be additionally hindered by weather conditions, travel difficulties, etc. Naturally, this is all the more true in the case of a global pandemic - slowing down investment and leaving the school community exposed to risk. The World Bank has partnered with the DxHub to develop AI4SIR to potentially reduce baseline data collection and analysis time by more than 30%, and overall cost by 50%.

The AI4SIR application leverages cloud-based, machine learning capabilities to classify the main school building structural taxonomy parameters using photographs of the structure taken in the field by local engineers, school administrators or members of the local community. The main parameters are classified into building category, main structural system and building height range which are the main characteristics influencing seismic vulnerability. Once uploaded, the photos are available for an expert to classify the buildings. An inventory of index

buildings will then develop into the school infrastructure baseline which will help to simplify classification at scale. Decision makers are able to maintain a comprehensive overview of their school infrastructure in near real-time. Such an inventory of index buildings will facilitate further fragility and vulnerability assessments of large school infrastructure portfolios and will inform local decision makers and development partners on the design of efficient risk-reduction intervention strategies and investment plans. This approach makes school infrastructure investment decisions more data-driven, provides a consistent and evidence-based assessment, and reduces the overall cost and time frame to actionable disaster risk-reduction investment.

"AI4SIR really accelerated our ability to support a government's understanding of their school infrastructure condition with a solid technical base. By far, infrastructure managers' biggest challenge is obtaining reliable assessment data for large portfolios of school facilities, in particular for those located in remote regions. Travel limitations imposed by the COVID-19 situation has exacerbated this challenge," said Fernando Ramirez Cortes, Task Team Leader of the World Bank's Global Program for Safer Schools. "*AI4SIR changes the game when it comes to scaling up efforts for school infrastructure resilience. In one dashboard, government stakeholders can see the baseline of school infrastructure by representative index buildings at both national and subnational levels. The dashboard also provides a vulnerability assessment per index building that is based on a rigorous structural analysis conducted by experts. Governments can save time and money by focusing their attention on better risk reduction strategy planning and resilient, learning-oriented school infrastructure investments."*

The first iteration of the application focused on the engineer as the primary data collector and user. A new Beta is being field tested that is much more user friendly for non-technical stakeholders to accelerate data collection.

"I can see a lot of school building photos becoming available on the dashboard every day. They are sent by the school principals from Osh Oblast using the AI4SIR mobile app," said a local engineer based in Bishkek, Kyrgyz Republic. *"Thanks to the mobile app, the photos uploaded to the dashboard are very organized and capture exactly the school building details we need to see. Based on these photos and the annotations suggested by AI4SIR, my structural classification work is much faster than before. I just need to conduct a quality control review of the classification done by AI4SIR on samples and make some minor corrections. The classification from AI4SIR was surprisingly accurate. After our quality assurance review, the results went straight to the Educational Management Information system to support the Ministry of Education in managing their school infrastructure. Such inspection, classification and inventory preparation work easily took months before, but now, without the need to travel to each individual site, we can deliver a high-quality school infrastructure inventory in almost half the time it used to take. There are still some data that we validate on the ground, but the more data we collect using AI4SIR, the better it gets with more accurate classification results.*

FREQUENTLY ASKED QUESTIONS

Engineer FAQ

Q: Do I need internet connectivity to use this tool or can I use it on my local machine?

A: The mobile app can be used offline for photo-taking. Once an internet connection is available, the data will be synced. For the annotation dashboard, we are assessing how we can integrate locally-run annotation tools and integration with simple data tables like .CSV files that could be exported and uploaded in bulk to AI4SIR once connected. This would allow the user to work offline and then sync files with the web-based version of AI4SIR, the primary location for shared school safety assessment data. We are evaluating the necessity and feature feasibility for future roadmap development.

Q: If I use this tool, how can I ensure that I am providing the same level of quality assessment that I would if I were to perform a manual inspection?

A: As an engineer, you are obligated to stand by your assessment of the structural classification of the building that you inspect on the ground as well as when using AI4SIR. The application is an augmentation tool that can help you make assessments faster and more efficiently. On the other hand, you will act like the AI4SIR's supervisor or teacher, in that you'll identify mistakes and allow the algorithm to learn from experienced engineers like you. If you have doubts about results that can't be resolved remotely, you should consider making an inspection on site for validation.

Q: Is there a standard or documentation on how to annotate the photos that are collected?

A: Annotation guidelines are embedded within the workflow along with descriptions and example photos. Additional annotation guidance and documentation can be discussed in further detail upon request.

Q: You mentioned that the algorithm gets better and better over time - how will it affect my work?

A: The application is designed to learn over time and should improve with the accumulation of data. This tool is designed to increase human capacity, quickly cover more ground, and communicate output directly to decision makers. The workflow requires experienced engineers to supervise or train the tool as new structural types will most likely appear with the evolution of engineering practices over time. Experts will be able to better assess large portfolios of school buildings both remotely and in the field.

Q: What if mobile or data service and availability of smartphone is a problem in the area?

A: The application can be designed such that photos can be stored locally on the device until a connection is established and photos can be uploaded. In the case of no availability of smartphones in the area, it is recommended that smartphones be provided to remote villages to complete assessments as this method of data collection is much more cost effective than sending personnel out into the field. If this approach is not an option, local region partners (e.g. engineering students) might be hired to conduct the photo collection with provided smartphones.

School Admin FAQ

Q: How will I know how to use this application?

A: The application will guide the user through taking a series of photos that will lead to the best output. It will instruct the user as to how to take pictures of the internal and external faces of the building which capture the major obvious structural elements and characteristics. Future improvements might even integrate AI-driven photo suggestions in the viewfinder.

Q: Do we still need to have an engineer visit and inspect the building?

A: The requirement for physical visits to a building location is largely dependent on the engineer's recommendation and level of confidence in the assessment of the documentation that was provided. Use of this tool should lessen the need for resources to perform field validation inspections.

Q: How will we know when our building(s) will be available for safety funding?

A: Governments will decide which schools will receive funding for seismic safety interventions. The decision makers will need to have a comprehensive overview of the building vulnerabilities per region/country to prioritize where the funds are needed most. The AI4SIR will facilitate to expedite a fully informed process.

Q: What do I do if I don't have a smartphone?

A: You can try to borrow a smartphone as the application only needs to be used temporarily. Alternatively, if there is an ongoing data collection activity led by the government or development partners, the application can be deployed with hired local teams (e.g. engineering students from local universities) that can be provided with an appropriate device/smartphone via support from the GPSS program.

Q: What do I do when I don't have internet service?

A: You can use the application without cell phone or data service. It will store the data until the device reaches internet connectivity and you will then have an opportunity to transmit the data to the AI4SIR cloud application. The results will be processed and provided to the relevant department for review.

Q: Does the application keep track of my location?

A: Yes, the application will store the GPS location of the phone while the application is being used to document your building. No cell phone connectivity is necessary for this to work. If the GPS location cannot be automatically identified, the application will ask you to pin your location on the map once you start using it to take photos. The school location information is important to identify the hazard level to which the school is exposed.

Regional/State Decision Maker FAQ

Q: How can we be assured that the results are accurate enough to base our infrastructure investment plan?

A: The current proof of concept developed by Cal Poly students has demonstrated accuracy of 81%, 95%, and 67% when classifying a building by the GLOSI (World Bank's Global Library of School Infrastructure) taxonomy system. The system focuses on the first 3 'primary' classifications including: the building category, main structural system, and number of stories respectively– See Final Documentation. Additional development will help to improve these scores significantly and more training data can be leveraged to train on the higher classification resolutions using further GLOSI taxonomy parameters. The project goal is to achieve a 90% or better accuracy rate for all key taxonomic classifications. The accuracy will improve over time as more data is generated though the production solution and added to the interactive machine learning workflow.

Q: How much money and time will this application save us?

A: We believe that this application could accelerate the assessment of nationwide school infrastructure safety by over 30% and save more than 50% in cost. Days of travel time for engineers/inspectors to remote locations could be reduced. Additionally, the speed through which photos and data can be captured on smartphones and uploaded to the internet is markedly faster than sending physical media through the mail.

Q: Who will own/operate this software?

A: Notwithstanding data sovereignty laws, this application would be ideally owned, operated, and maintained by a centralized entity across multiple countries/regions.

Q: What would be the cost?

A: The application will be free.

Q: Aside from mobile connectivity issues, how quickly will data become available and how often will it be updated?

A: The photos and data will become available as a function of how fast the data is collected and transmitted to the cloud application. Once the photos have been uploaded and annotated, and ingested into the web services API, machine learning results on the structural classification will be processed and ready for multiple user consumption within seconds or minutes, providing a near-real time consumption experience. Future releases may include a desktop client/extension that will intermittently sync to the cloud while allowing users to continue their workflow offline.

Q: Who will own the data and how do we address data privacy concerns?

A: Data ownership will have to be addressed in compliance with the region, country or municipality being served. In general, the data collected will not be public until relevant stakeholders agree to share the data publicly.

<u>World Bank (Business Unit) FAQ</u>

Q: How much is this going to cost and how do we pay for it?

A: We have a proof of concept (POC) underway, and are earmarking funding for further POC work to establish the overall value proposition, technical feasibility, business case, cost and pathway to implementation. We will assess next steps based on the evidence developed to de-risk this project before making an implementation decision.

Q: How will we know if/when this solution is appropriate for implementation and what will it look like?

A: We will stage a project timeline starting with the current POC. This timeline will include concurrent development phases that will refine the project design, address the technical and programmatic feasibility, and provide an on-the-ground pilot testing/validation and design refinement opportunity. This will help the World Bank task team to frame go/no-go milestones leading to a comprehensive solicitation that will result in a production software solution.

Q: How do we address data sovereignty issues if they arise from our client countries?

A: Data sovereignty issues will need to be handled individually based on client country data law and World Bank information management policies.

Q: What metrics and KPIs will be used to measure success?

A: KPIs and metrics will be iteratively developed over time but the main goal of the project is to reduce the time and cost needed in data collection and analysis for school infrastructure inventory in developing countries. Additional impact metrics that may be measured include the amount of data collected and schools assessed, usage and adoption in the field, the accuracy of individual prediction models, the rate at which the models improve, the overall accuracy of the assessment of each individual school, and the number of schools prioritized and structurally mitigated in relation to the school's predicted risk.

TESTIMONIALS FROM KEY CUSTOMERS FOR USER STORY DEVELOPMENT

Engineer/Inspector

"I can see a lot of school building photos becoming available on the dashboard every day. They are sent by the school principals from Osh Oblast using the AI4SIR mobile app," said a local engineer based in Bishkek, Kyrgyz Republic. *"Thanks to the mobile app, the photos uploaded to the dashboard are very organized and capture exactly the school building details we need to see. Based on these photos and the annotations suggested by AI4SIR, my structural classification work is much faster than before. Reviewing and annotating thousands of school building photos was very time-consuming before, especially when the photos were not capturing some key structural features. But now AI4SIR promotes the ability to take photos on the ground and helps in the identification of the most important structural characteristics. I just need to conduct a quality control review of the classification done by AI4SIR on samples and make some minor corrections. The classification from AI4SIR was surprisingly accurate. After our quality assurance review, the results went straight to the Educational Management Information system to support the Ministry of Education in managing their school infrastructure. Such inspection, classification and inventory preparation work easily took months before, but now, without the need to travel to each individual site, we can deliver a high-quality school infrastructure inventory in almost half the time it used to take. There are still some data that we validate on the ground but the more data we collect using AI4SIR, the better it gets with more accurate classification results."*

School Administrator

"I recommended that my friend download the new AI4SIR app on his phone," said a school principal from a village of Jalal-Abad Oblast, in the Kyrgyz Republic. *"He is the only one in the village that has a smartphone but he knows that the app will help us to attract investments for safer and better schools in the village, including the school where his daughter studies, so he let me borrow it. The app walked me through the basic steps of taking pictures of the school building, on both the inside and the outside, including the columns we see in the lobby and the spalling wall. We don't have very good cell phone coverage in our village but when my friend went to the nearest town during weekends, he made sure that the photos got uploaded successfully and were sent to the engineers. We are hoping that the Ministry of Education will be aware of our schools' condition soon and we can hopefully receive some financial help to fix them because they are in such bad shape."*

Public Sector Decision Maker

"AI4SIR is great," said a representative from the Ministry of Education. *"We did a school infrastructure data collection campaign using AI4SIR this year to document the baseline structural information and support the seismic vulnerability assessment of as many school buildings as we could. We think we got close to 70% in just 1 month! AI4SIR lets me see the baseline of our school infrastructure at national, oblast and municipality levels by representative building types. Soon we will be able to plot the distribution of seismic risk from the assessment results of these representative building types performed by our engineers. We are already aware of the alarming levels of adobe school buildings concentrated in a few regions. Once further risk assessment results become available, we will be able to implement our state program to improve school safety with an investment plan that we know will benefit the most students. AI4SIR really enables us to quickly develop an evidence-based, strategic investment and implementation plan to mitigate seismic risks in our schools. We feel really confident that we can have the biggest and fastest impact on school safety given our budget constraints."*
