Digital Solutions for Bridging Language Barriers: A Review of Apps for Construction Spanish Safety Communication on Construction Jobsites

Adrian Cappella[1], Shima Clarke[1], Jason Lucas[1]
[1]Clemson University

Language barriers in the construction industry, particularly among Spanish-speaking workers, present significant challenges to safety communication, leading to increased risks of accidents and injuries. As the construction workforce becomes more diverse, the need for effective and clear communication of safety protocols in multiple languages has become critical. This study reviewed and evaluated the effectiveness of various digital tools designed to improve safety communication for Spanish-speaking workers on construction sites. Tools such as Need2Say, JHA Safety App, and Toolbox Talks Safety App provide real-time translations, bilingual safety briefings, and customizable hazard analysis, which help reduce the risks associated with miscommunication. This research also explored the limitations of general-purpose tools like Google Translate, which lack industry-specific terminology. Through a comprehensive analysis, this study highlights the strengths and weaknesses of these digital tools and suggests future improvements, including the integration of augmented reality training and data analytics to enhance safety outcomes. This study provides a framework for assessing the current and potential role of digital tools in creating safer, more inclusive construction environments.

Keywords: Construction safety, language barriers, digital tools, Spanish-speaking workers, safety communication

Introduction

In 2021, foreign-born Hispanic workers experienced a concerning rise in workplace fatalities, accounting for 14% of all U.S. work-related deaths despite comprising only 8.2% of the workforce. These incidents were especially prominent in construction, where fatal injuries due to falls and similar hazards are prevalent (Bureau of Labor Statistics, 2023a; Bureau of Labor Statistics, 2023b). Hispanic construction workers are 35% more likely to suffer a fatal injury on the job compared to their non-Hispanic counterparts. This disparity is mainly attributed to language barriers and insufficient safety training (Lavy et al.,2010), underscoring the urgent need for tailored safety programs that address the linguistic and cultural challenges faced by Hispanic workers (Siddiqi & Zai, 2003).
Figure 1 presents data on workplace fatalities from 2019 to 2023, drawn from the U.S. Bureau of Labor Statistics (BLS), and highlights a concerning trend: foreign born Hispanic or Latino workers have persistently high fatality rates relative to the total construction workforce. These statistics highlight the dire need for communication tools that are specifically suited for construction job sites.

According to the data from the BLS, it is evident that many of these issues can be addressed by new digital tools and applications that bridge communication gaps, increase comprehension, and ultimately help improve safety outcomes on construction sites.
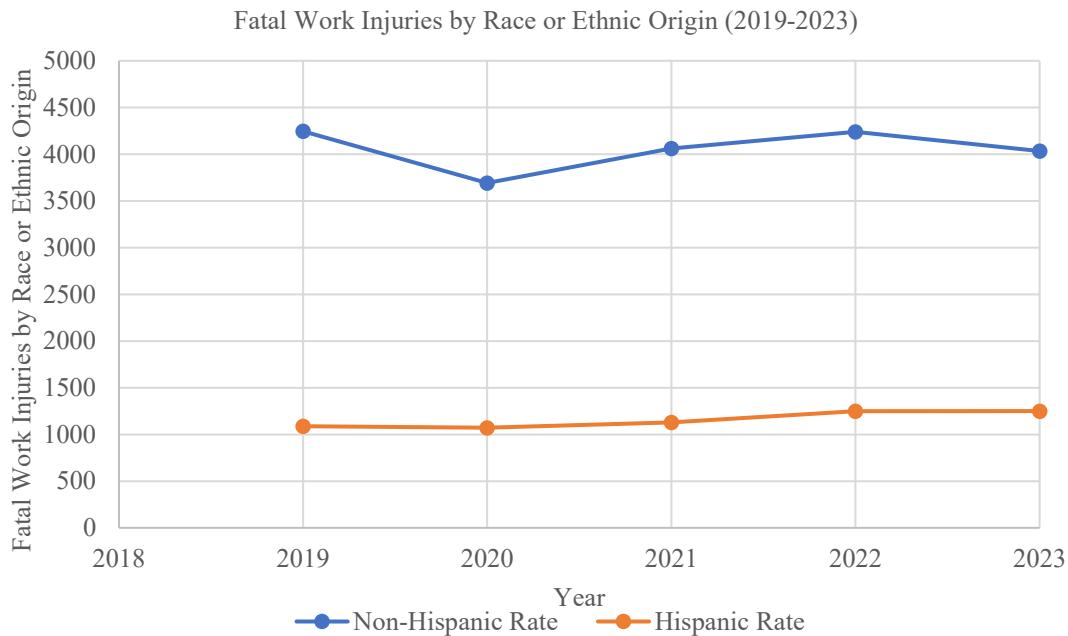
Fatal Work Injuries by Race or Ethnic Origin (2019-2023)

Figure 1. Fatal Work Injuries by Race or Ethnic Origin (2019-2023) (U.S. Bureau of Labor Statistics, 2023)

The Role of Digital Tools in Construction Safety Communication

The literature review revealed that language barriers pose a significant risk in the construction industry, particularly among Hispanic workers, who often lack proficiency in English (Irizarry, 2009). As such, digital tools have emerged as crucial resources for enhancing safety communication, providing immediate access to translations, and delivering construction-specific language training. These tools aim to reduce the miscommunication that can lead to accidents and injuries on job sites, with research consistently showing that Hispanic workers face higher rates of job-related fatalities (Canales, 2004; Lyu et al., 2023).

Recent research studies highlight the potential use of digital tools in overcoming these linguistic and cultural challenges. The use of interactive multimedia training, mobile applications, and audio-visual platforms has emerged as a promising approach to improving safety outcomes for non-English-speaking workers (Cocerhan & Bradley, 2019). These tools not only make safety information more accessible but also enhance worker engagement, leading to improved comprehension and safer practices on construction sites (Dlaska, 2002).

Moreover, pilot studies have shown that mobile applications like Google Translate can significantly improve task completion times and reduce misunderstandings among Spanish-speaking workers, resulting in safer and more efficient job sites (Cocerhan & Bradley, 2019). By integrating these digital

tools into safety training programs, construction companies can better meet the needs of their diverse workforce and reduce the risks associated with language barriers (Irizarry, 2009). Additionally, Google Translate does not consider cultural nuances or technical jargon often used in construction, which limits its effectiveness for precise safety communication (Cocerhan & Bradley, 2019; Irizarry, 2009)

The goal of this paper is to review and evaluate the effectiveness of existing digital tools designed to improve safety communication between Spanish-speaking workers and English-speaking supervisors on construction jobsites. This paper will report on the advantages and disadvantages of digital tools used on construction jobsites to bridge the language gap/communication and make recommendations for further research.

Methodology

The research methodology was completed in two distinct phases. The first phase consisted in reviewing extensively existing literature on technologies and applications applied towards improving communication in Spanish language on construction sites. The translation capabilities, general communication features, and safety specific functionalities of various tools were carefully examined from the literature to produce information useful for making such choice.

A definition of the research objectives leads to the determination of parameters for the review. Studies that deal with language barriers in the construction industry, research that discusses challenges faced by Hispanic workers in the process of communication safety and studies that illustrate applications for translation, safety and efficient communication were considered key. Google Scholar, ResearchGate, ScienceDirect, Scite and Clemson University libraries were the primary search engines used during this phase. Hispano-American workers, Hispanic communication, communication barriers, safety applications, safety and keywords such as "Hispanic" and "Hispano" were used to find relevant sources. Internet search as well as the literature review were used to establish the quality characteristics/dimension of a translator shown in the Tool Row of Table 1. Grammarly was used to assist in writing clarity and identify grammatical issues.

Eleven tools were identified based on their applicability to construction safety communication and the availability of language assistance for Spanish-speaking workers. These tools included mobile application and website solutions that offered features such as real-time translation, detailed safety information, OSHA-compliant briefings/safety messages, step-by-step safety instructions, and general jobsite construction communication. Additionally, the strengths and weaknesses of each tool were evaluated for accuracy by determining if it was accurate to what the person is trying to say, cultural sensitivity, understanding the dialect of the person, and construction relevant safety information. This data was tabulated with features identified with an X.

The second phase of the research involved testing the tools by a member of the research team in a controlled environment simulating typical job site communication scenarios. This included testing the effectiveness of real time translation, how well the tools translated safety specific and cultural communication, including the ability to recognize different Spanish dialects. The research team member is a bilingual, native Central American project engineer who has been in the industry for the past 5 years. Using industry experience and bilingual background, the research team member also identified strengths and weaknesses in usability and the provision of relevant construction safety information.

Analysis and Discussion

The eleven identified tools from the literature review are listed and their translation features and characteristics related to construction Spanish are summarized in Table 1. The quality dimension encompasses several key factors: coherence, industry specificity (construction-related terminology), accuracy, cultural appropriateness and interactivity. This is important, as they continue to be essential for ensuring that translations are at least linguistically precise but also contextually fitting and comprehensible to those on the construction jobsite. The most versatile tools for bridging language gaps in construction are shown in this comparative analysis. This evaluation shows the translation features/characteristics that each tool possesses. Strong performance across these criteria means that these tools may bridge the communication gap that exists on construction jobsites.

Table 1. Comparative Analysis of Translation Features and Characteristics of Digital Tools for Construction Safety Communication

Tool	Type		Speed		Quality				
Column Row	1	2	3	4	5	6	7	8	9
Need2Say [7]	x	x	x		x	x	x	x	x
Google Translate [3]	x	x	x						x
Toolbox Talks Safety App [10]	x			x	x	x		x	
JHA Safety App [5]	x			x	x	x	x	x	x
ISpeak [4]	x		x						x
Voxy [11]	x	x	x			x	x	x	x
Mango Languages [6]	x	x	x			x	x	x	x
Procore Translations [9]	x	x	x		x	x	x	x	
Speak & Translate [1]	x		x						x
Babel Fish Voice [2]	x		x						x
SmartTagit [8]	x		x		x	x		x	x

Note: **Tool Column**, see reference section: [1]=Apalon (n.d.), [2]=BabelFish Corporation [2018], [3]=Google (n.d.), [4]=ISpeak (n.d.), [5]= JHA Safety (2024), [6]= Mango (n.d.), [7]= Need2Say (n.d.), [8]= FactorLab (2022), [9]= Procore Technologies (2024), [10]= Washington State Construction Center of Excellence (2023), [11]= Voxy (n.d.).
Tool Row: 1= App, 2= Website 3= Real Time, 4= Lag/Delayed, 5= Construction Specific, 6= Coherent, 7= Culturally Appropriate, 8= Accurate, 9= Interactive

The comparative analysis of the 11 digital tools for translation, as shown in Table 1, identifies dissimilarities regarding features and characteristics to support safety communication on the construction site. The tools identified as most comprehensive are Need2Say and JHA Safety App, which provide construction-specific language support, coherence, cultural appropriateness, accuracy,

and interactivity. Real time translation is what allows for Need2Say to be used for immediate job site communication. In contrast, JHA Safety App succeeds with structure safety processes with a lag or a delayed translation.

Real time support and basic interactivity are provided by general-purpose tools such as Google Translate, Speak & Translate and Babel Fish Voice, which have construction-specific terminology and cultural appropriateness but are not sufficient to provide safety communication. Toolbox Talks Safety App and Simple Instruct are effective for planned safety briefings but are not quite up to the task of real time communication because of delayed translation. Both the language learning platforms Voxy and Mango Languages are designed for comprehensive support in the given language with cultural relevance and interactivity; however, they are not designed to suit construction needs. The reasons for the selected tools were their applicability to safety communication methods and whether they could fulfill the language support needs of Spanish-speaking construction workers. The analysis showed that Need2Say was the most versatile option, offering a real-time translation, focusing specifically on construction and dealing with the culture efficiently to keep on and talk and make communication clear and understandable on construction sites. The translation requirements unique to construction safety communication are appropriately mirrored in the emphasis on tools utilized in this analysis.

Effectiveness of Digital Tools

A comparative analysis of the 11 digital tools evaluated for their suitability in improving safety communication on construction job sites for Spanish speakers is shown in Table 2. A comparison of Job Site communication relevant traits such as OSHA specific material, general safety instructions, cultural appropriateness and functionality for general communication and inspections is illustrated in Table 2. The table demonstrates which tools have safety and communication support that can enable the use of tools to meet safety and communication needs in a variety of construction environments.

Table 2 shows that digital tools like Need2Say (n.d.) and Washington State Construction Center of Excellence (2023) possess jobsite communication features and characteristics to bridge the safety communication gap on job sites, especially for Spanish-speaking workers. Workers in hazardous environments who do not speak or fully understand English find themselves with a 'communication gap': OSHA-compliant, Spanish language safety instructions from Need2Say fills this gap and assist supervisors in guiding their workers with need-to-know safety procedures (Need2Say, n.d.). Need2Say does, however, require the users to read the instructions and may not be accessible to low literacy workers. Moreover, it misses out on more advanced potential – ideally, data analytics would enable further safety compliance insights and help avert incidents.

Toolbox Talks Safety App is another great tool for a structured bilingual safety briefing, providing OSHA-specific content and general safety instructions (Washington State Construction Center of Excellence, 2023). It also requires workers to read the safety information, it can be useful for planned safety meetings but not real time communication.

Google Translate has a free translation service with integrated text and voice translation options. Because of their lack of construction-specific terminology and contextual safety, it does not seem effective for safety-critical tasks on construction sites (Google, 2022). This reinforces that industry-specific tools that address the nuances of talking about construction safety are necessary.

Table 2. Comparative Analysis of Jobsite Communication Features and Characteristics of Digital Tools for Construction Safety

Tool	Type		Safety			General Communication	Inspections, Utilities & Services
Column Row	1	2	3	4	5		
Need2Say [7]	x	x	x	x	x	x	x
Google Translate [3]	x	x				x	
Toolbox Talks Safety App [10]	x		x	x		x	
JHA Safety App [5]	x		x	x	x	x	x
ISpeak [4]	x					x	
Voxy [11]	x	x			x	x	
Mango Languages [6]	x	x				x	
Procore Translations [9]	x	x	x	x	x	x	
Speak & Translate [1]	x					x	
Babel Fish Voice [2]	x					x	
SmartTagit [8]	x		x	x	x	x	x

Note: **Tool Column**, see reference section: [1]=Apalon (n.d.), [2]=BabelFish Corporation [2018], [3]=Google (n.d.), [4]=ISpeak (n.d.), [5]= JHA Safety (2024), [6]= Mango (n.d.), [7]= Need2Say (n.d.), [8]= FactorLab (2022), [9]= Procore Technologies (2024), [10]= Washington State Construction Center of Excellence (2023), [11]= Voxy (n.d.).
Tool Row: 1= App, 2= Website, 3= OSHA Specific, 4= General Instructions, 5= Cultural

As a robust construction hazard analysis platform, the JHA Safety App allows users to create and utilize customized templates as well as bilingual options to perform a risk analysis in English and Spanish. Like Toolbox Talks Safety App and Need2Say, it relies on written communication (JHA Safety, 2021), so users need to read the instructions and fill in the forms, which does not allow for immediate conversational communication (JHA Safety, 2024).

Simple Instruct is perhaps the best, ensuring users see step-by-step safety instructions in multiple languages, but does force them to read preexisting safety tasks first. It is less flexible when used in dynamic construction environments where real-time adaptation is needed (Simple Instruct, 2021). Voxy (n.d.) and Mango (n.d.) are both used for general language skills, focusing on construction terminology, but are not construction-specific nor OSHA-compliant and, therefore, cannot serve as vehicles to provide task-specific OSHA-compliant communication on the job site (Dlaska, 2002).

User Engagement and Feedback

The user feedback indicates that the Need2Say (n.d.) and Washington State Construction Center of Excellence (2023) did a good job of communicating with Spanish-speaking workers by providing structure and OSHA-compliant instructions (Eddy & Herrera, 2004; Washington State Construction Center of Excellence, 2023). For instance, many think Toolbox Talks Safety App is especially great with its structured, bilingual safety briefings — which most workers can understand without too much reading (they are text-based).

The clear step by step instructions offered by other tools such as Simple Instruct (2021) are well received, however as they are based on predetermined tasks. Simple Instruct (2021) is less adaptable to construction job sites fluidity.

Limitations of Existing Tools

Many of these tools have some essential safety communication support, but there are no real-time construction-specific translation features. Google Translate and ISpeak are general-purpose translation tools as well as voice, but they cater to the general, not specialized vocabulary of programming that will allow for misunderstanding in critical safety scenarios (ISpeak, n.d.).

Furthermore, although Need2Say (n.d.) and the JHA Safety App (2024) are excellent at communicating safety, they are not fully immersive and may not work for every kind of safety scenario. As Arif et al. (2021) stated, more advanced solutions, such as the immersive virtual reality tool framework, like the ConSafe4All, can offer hands-on safety training in simulated environments where workers can practice using safety protocols in their language of preference. It could bridge a gap in real world applicability where instructions on paper might not be sufficient.

Furthermore, Irizarry (2009) notes that although digital tools effectively enhance communication, the majority do not take into consideration the cultural differences between workers that influence the way safety instructions are understood and responded to. It shows that language tools must be combined with training in culture to have a comprehensive safety communication strategy.

Conclusion

The use of digital tools and apps for improving safety communication on construction sites has greatly advanced efforts to overcome language barriers, particularly for Spanish-speaking workers. As the construction industry diversifies, effective communication is increasingly critical to ensure all workers understand and follow safety protocols, regardless of their language skills.

The comparative approach of this research resulted in identifying tools that were most efficient for translation quality and job site communication while also keeping in line with trade standards and practices. The approach facilitated the identification of tools that effectively bridge language barriers and enhance the safety of Spanish-speaking workers within construction environments.

This study highlights the effectiveness of tools like Need2Say, JHA Safety App, and Toolbox Talks Safety App, which provide real-time translations, bilingual briefings, and customizable hazard analysis. These industry-specific tools offer significant advantages over general-purpose options like Google Translate by including construction-relevant terminology. However, many current tools lack the depth, technical specificity, and cultural considerations necessary for all safety scenarios, and some are limited by predefined phrases.

The study findings suggested that these tools could greatly enhance communication with Spanish-speaking workers. Yet, the evaluation showed where improvements need to be made, including offline functionality and the adaptability of the tools to the wide variety of dialects. The results indicate that the effectiveness of these tools needs to be further tested in real job-site conditions with more extensive testing and a broader range of users.

Research Limitation

The assessment of the tools was completed by the research team and not validated by outside experts. This can lead to possible bias for the tools assessment.

Recommendations for Further Research

There is a clear need for more comprehensive, adaptive tools that combine real-time translation with advanced safety training. The development of immersive technologies, such as augmented and virtual reality platforms, presents an opportunity to give workers hands-on experiences in a controlled environment where they can learn safety protocols in their own language, enhancing both comprehension and preparedness, particularly in high-risk job scenarios. In addition, integrating data analytics into these tools would enable construction companies to track the effectiveness of their safety communication strategies and identify areas that require further training or improvement.

While digital tools have made significant progress, further innovation is essential to fully address language and cultural challenges on job sites. Continued development of these technologies will lead to safer, more inclusive work environments where communication is clear, accurate, and accessible to all workers.

References

Apalon. (n.d.). Speak & Translate (Version 4.5) [Mobile app]. Apple App Store. https://apps.apple.com/us/app/speak-translate-translator/id804641004

Arif, M., Nasir, A. R., Thaheem, M. J., & Khan, K. I. A. (2021). ConSafe4All: A framework for language friendly safety training modules. *Safety Science, 141*, 105329. https://doi.org/10.1016/j.ssci.2021.105329

BabelFish Corporation. (2018). *About*. https://www.babelfish.com/about-us/

Canales Fernández, A. (2004). *Developing effective integration between American supervisors and Hispanic craft workers in construction* [Doctoral dissertation, Iowa State University]. Iowa State University Digital Repository. https://dr.lib.iastate.edu/entities/publication/de327d67-0f7e-489e-a362-8191d361e89a

Coffey, R. D. (2020). *Learning Styles of Undergraduate Construction Management Students and Their Impact on Best Practices for Online Education* [Master's thesis, Clemson University]. Clemson open. https://open.clemson.edu/all_theses/3324/

Cocerhan, I., & Bradley, J. (2019). *Investigation into how technology can overcome*

*language barriers experienced by construction workers from Eastern Europe on sites in Lond*on. In C. Gorse & C. J. Neilson (Eds.), *Proceedings of the 35th Annual ARCOM Conference* (pp. 537-545). Association of Researchers in Construction Management. https://www.researchgate.net/publication/336020722_Investigation_into_How_Technology_Can_Overcome_Language_Barriers_Experienced_by_Construction_Workers_from_Eastern_Europe_on_Sites_in_London

Dlaska, A. (2002). Sites of construction: Language learning, multimedia, and the international engineer. *Computers & Education, 39(*2), 129–143. https://doi.org/10.1016/S0360-1315(02)00031-3

Easy Tiger Apps. (n.d.). Speak & Translate (Version 4.5) [Mobile app]. https://apps.apple.com/us/app/speak-translate-translator/id804641004

Eddy, T., & Herrera, A. (2004). *Learning Construction Spanglish*. McGraw-Hill Professional.

FactorLab. (2022). *SmartTagit* [Mobile app]. https://factorlab.com/smarttagit-2/#

Google. (n.d.). Google Translate. Retrieved November 6, 2024, from https://translate.google.com/

Hutchings, D. M., Loayza, P. I., Christofferson, J. P., & Burr, K. L. (2012). Safety issues among Hispanic construction workers along the Wasatch Front in Utah. *48th ASC Annual International Conference Proceedings*. http://ascpro0.ascweb.org/archives/cd/2012/paper/CPRT226002012.pdf

Irizarry, J. (2009). *Technology-enhanced safety training for the Hispanic workforce.*. https://www.researchgate.net/publication/254544168_Technology-Enhanced_Safety_Training_For_the_Hispanic_Workforce

ISpeak. (n.d.). Training solutions. https://ispeak.com/training-solutions/

JHA Safety. (2024). *JHA Safety*. https://www.jhasafety.com/

Jobble. (n.d.). *Jobsite Spanish: 100+ phrases & terms for construction sites & warehouses.* https://jobble.com/articles/jobsite-spanish-terms-construction-and-warehouses/

Lavy, S., Aggarwal, C., & Porwal, Vishal. (2010). 'Fatalities of Hispanic Workers: SafetyInitiatives Taken by U.S. Construction Companies to Address Linguistic and Cultural Issues'. *International Journal of Construction Education and Research, 6*(4), 271-284. http://dx.doi.org/10.1080/15578771.2010.514693

Lyu, S., Hon, C. K. H., Chan, A. P. C., Jiang, X., & Skitmore, M. (2023). Critical Factors Affecting the Safety Communication of Ethnic Minority Construction Workers. *Journal of Construction Engineering and Management, 149*(2). https://ascelibrary.org/doi/10.1061/JCEMD4.COENG-12680

Mango. (n.d.). *How Mango Works.* https://mangolanguages.com/how-it-works/

Need2Say. (n.d.). *Need2Say Solutions* https://www.need2say.com/solutions/

Procore Technologies. (2024). *What languages can be automatically translated in the Conversations tool?.*. https://support.procore.com/faq/what-languages-can-be-automatically-translated-in-the-conversations-tool

Saborio, A. (2022). *Developing Mexican and Central American Spanish phrases for U.S. construction workforce to improve jobsite communication* [Master's thesis, Clemson University]. Clemson University TigerPrints. https://tigerprints.clemson.edu/all_theses/3940

Siddiqi, K., & Zai, D. (2003). *Best practices for improving safety among Hispanic construction workers. Kennesaw State University.* https://www.researchgate.net/publication/252150541_Best_Practices_for_Improving_Safety_among_Hispanic_Construction_Workers

Simple Instruct. (2021). *Simple Instruct: Multilingual step-by-step safety instructions.* Retrieved November 6, 2024, from https://www.simpleinstruct.com/

U.S. Bureau of Labor Statistics. (2023). *Number of fatal work injuries by race or ethnic origin. U.S. Department of Labor.* Retrieved from https://www.bls.gov/charts/census-of-fatal-occupational-injuries/number-of-fatal-work-injuries-by-race-or-ethnic-origin.htm

U.S. Bureau of Labor Statistics. (2023a). *National Census of Fatal Occupational Injuries in 2021.* Retrieved from https://www.bls.gov/news.release/cfoi.nr0.htm

U.S. Bureau of Labor Statistics. (2023b). *Economic News Release: Census of Fatal Occupational Injuries Summary, 2021*. Retrieved, from https://www.bls.gov/iif/oshcfoi1.htm

Voxy. (n.d.). *Voxy Platform.* https://voxy.com/voxy-platform/

Washington State Construction Center of Excellence. (2023). *Toolbox Talks Safety App.* https://www.constructioncenterofexcellence.com/toolbox-talks-app

White, R. (2021). *How to Overcome Language Barriers in Construction.* https://ivannovation.com/blog/language-barriers-in-construction/

Zhang, X., Wu, Y., Shen, L., & Skitmore, M. (2014). A prototype system dynamic model forassessing the sustainability of construction projects. *International Journal of Project Management, 32*(1), 66–76. https://doi.org/10.1016/j.ijproman.2013.01.009