

Safety and Health Investment Projects FINAL REPORT REQUIREMENTS

The purpose of the final report of your SHIP project is to:

1. Evaluate and document the achievements, challenges, and shortcomings of the project for the constructive benefit of others interested in learning from SHIP projects; and
2. Provide the Division of Occupational Safety and Health with information that shows:
 - a. The outcomes specified in the project application were met; and
 - b. The grant was used for the purpose(s) for which it was approved and in accordance with relevant WAC rules and any special conditions or requirements; and
 - c. The outputs of the project have been disseminated as specified in the application.

The report format has four sections:

1. Cover Sheet
2. Narrative Report (part I)
3. Financial Information (part II)
4. Attachments (part III)

Please provide complete and detailed information in the final report. If you have questions, please call your SHIP grant manager.

REMINDER!!: All products produced, whether by the grantee or a subcontractor to the grantee, as a result of a SHIP grant are in the public domain and can not be copyrighted, patented, claimed as trade secrets, or

SAFETY AND HEALTH INVESTMENT PROJECTS FINAL REPORT

Develop a Lean Practice Manual
for Improving the Safety of Electrical Construction Workers
2017ZH00349
4/1/2018 – 6/30/2019

Hyun Woo Lee
hyunwlee@uw.edu

University of Washington and
National Electrical Contractors Association – Puget Sound Chapter

September 12, 2019

Hyun Woo Lee



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University of Washington and National Electrical Contractors Association – Puget Sound Chapter is solely responsible for the content of and views expressed in this report and related materials unless they have been formally endorsed by the Washington State Department of Labor and Industries.

PART I

Narrative Report

Abstract:

Present a short overview of the nature and scope of the project and major findings (less than half a page).

Lean construction is a comprehensive management approach that aims to enhance value on construction projects and eliminate waste through project lifecycles. A large number of studies have reported the effectiveness of lean practices in optimizing production on construction projects by improving productivity, eliminating waste, and increasing value delivered to customers. As a result, lean construction has gained significant interest from the US construction industry in the last couple of decades.

Initially, lean construction focused mainly on production management; in recent years, the construction industry has begun to realize that the lean approach can also be beneficial for improving worker safety. However, few studies have been done to evaluate the use of lean practices in terms of construction safety, and there is no formal documentation available that specifically details how lean techniques can actually be applied to reduce construction safety risks in practice. This lack of available guidelines appears to be the main barrier to the implementation of lean safety practices in the construction industry.

In response, the project team successfully published and disseminated a Lean and Safety manual, entitled “Lean and Safety Manual for Electrical Construction”. The manual consists of best practices when implementing lean techniques and tools to improve worker safety, as applicable electrical contractors. The manual is designed to be a step-by-step manual that contains implementation protocols and examples with pictures and illustrations.

The manual has been well received with evidence that companies are interested in using it for their own safety practices.

Purpose of Project:

Describe what the project was intended to accomplish.

The purpose of the project was to develop a Lean and Safety manual to show how lean practices and safety practices can be combined effectively to support electrical contractors. Based on interviews with industry practitioners and case studies, the manual is focused on lean techniques that have significant potential to improve worker safety. These techniques include: 5S, Last Planner System (LPS), continuous improvement, prefabrication, and 5 Whys. While the manual is specifically designed as an easy-to-use, step-by-step guideline for electrical contractors, it could prove useful to interested parties in other construction trades when implementing lean practices for worker safety.

Statement and Evidence of the Results:

Provide a clear statement of the results of the project include major findings and outcomes and provide evidence of how well the results met or fulfilled the intended objectives of the project.

The main objective of the project was to develop and disseminate a Lean and Safety manual, entitled “Lean and Safety Manual for Electrical Construction”. To achieve the objective, the following activities were performed during the project duration.

- A group of eight industry professionals were recruited as the Industry Advisory Committee, who provided guidance, feedback, and insights during the development of the manual. In addition to email communications, the Advisory Committee met every quarter in official meetings where the project team presented progresses and the Committee offered valuable feedback. The involvement of the Committee significantly contributed to the successful completion of the project.
- Throughout the project, a total of 15 interviews were performed with 23 professionals from 15 companies. In addition, four case studies were performed and captured as industry best practices in Lean and Safety.
- As a result, 1500 copies of manuals were published, 625 of which were delivered to the SHIP office on 6/22/2019. The project team has been using the remaining copies for their own disseminations.

To disseminate the manual to the Washington State Construction Industry, the following activities were successfully performed.

- The manual was formally presented to over 50 safety managers of WA companies in two safety meetings: National Electrical Contractors Association (NECA) -Puget Sound Chapter on 5/10/2019 (about 15 professionals) and Associated General Contractors (AGC) of Washington on 6/6/2019 (about 45 professionals).
- Over 500 hard copies have been mailed to construction professionals and construction companies in WA.
- The manual in PDF has been posted online, including www.researchgate.net and the website of the UW Department of Construction Management.
- Lastly, the manual will be further disseminated for broad impact through academic publications and academic conferences.

Measures to Judge Success:

If relevant, state what measures or procedures were taken to judge whether/ how well the objectives were met and whether the project or some other qualified outside specialist conducted an evaluation.

Mainly two measures were taken to determine the level of success. First, the manual was formally presented to the Advisory Committee, NECA members and AGC members, all of which provided positive feedback. Second, an online survey was distributed to WA construction companies and the responses are all positive (refer to the feedback section).

Relevant Processes and Lessons Learned:

Specify all relevant processes, impact or other evaluation information which would be useful to others seeking to replicate, implement, or build on previous work

AND

Provide information on lessons learned through the implementation of your project. Include both positive and negative lessons. This may be helpful to other organizations interested in implementing a similar project.

The following processes are suggested for those who wish to replicate our work as performed in this project:

1. Perform extensive literature review to identify gaps in practices, as the point of departure.
2. Establish an industry advisory committee that is consisted of subject matter experts. The advisory committee will play a pivotal role to provide guidance and feedback throughout the project.
3. Perform extensive interviews with industry practitioners to gain their perspectives and opinions on the subject matter. During the interviews, it is important to identify case study opportunities.
4. Perform case studies to capture contextually rich information, which should help establish the current best practices of leading companies in the industry.
5. Analyze and cross-check the case studies against the interview data.
6. Present overall results to the advisory committee and seek their feedback.
7. Develop a documentation with the captured best practices, as the main product of the project.
8. Disseminate the project product to the target audience and collect their feedback as the measurement of success.

One important lesson learned from the project is related to the publication and dissemination sides of the project. While it is hard to forecast at the start of a project, it can be a great idea to get a production company on board early so that the plan and budget for publication and dissemination can be established as early and accurate as possible.

Product Dissemination:

Outline of how the products of the project have been shared or made transferrable.

As briefly mentioned earlier, the manual has been disseminated via various different channels for broad impact.

Presentations - The manual was formally presented to the following industry professionals:

- Safety managers of about 15 NECA-Puget Sound member companies on 5/10/2019 at the NECA-Puget Sound office
- Safety managers of about 45 AGC of Washington member companies on 6/6/2019 at the AGC-WA office.

Hard-copy disseminations including:

- 60 copies to NECA-Puget Sound
- 50 copies to NECA-Inland Empire
- 50 copies to NECA-Cascade
- 50 copies to NECA-South West Washington
- 100 copies to AGC of WA
- 35 copies to Lean Construction Institute (LCI)-Cascadia-Seattle CoP (Community of Practice)
- 50 copies to Oregon NECA member companies through Prof. John Gambatese
- 100 copies for individual disseminations by the Advisory Committee

PDF disseminations through:

- PDF posted to researchgate.net
- PDF posted to the website of the UW Department of Construction Management
- A link to PDF was shared in an online survey that was distributed to the members of NECA-Puget Sound and LCI-Cascadia-Seattle CoP

Feedback:

Provide feedback from participants, trainees, individuals who have used your products/processes, as well as any reports from an independent evaluator on the project.

Formal feedback has been collected in terms of four criteria (Quality of Content; Ease of Use; Relevance to Your Work; and Potential to Improve Worker Safety), via online survey based on Google Forms. A total of 21 responses were collected and they are largely positive as summarized below:

Criteria	Excellent	Very Good	Good	Fair	Poor
Quality of Content	42.9%	33.3%	23.8%	0%	0%
Ease of Use	47.6%	33.3%	14.3%	4.8%	0%
Relevance to Your Work	23.8%	61.9%	14.3%	0%	0%
Potential to Improve Worker Safety	38.1%	47.6%	9.5%	4.8%	0%

The survey participants provided positive comments, as follows:

- “We are already using these programs. and have seen an improvement in workers safety and performance.”
- “Very easy to follow and well explained throughout.”
- “Charts, diagrams, pictures are all great media for providing additional detail. Great use of media to help capture the attention of those that are more "visual".”
- “Quality was very good.”
- “I thought it was very good. good presentation and content.
- “Excess clutter, poor housekeeping and lack of/improper planning will always lead to worker frustration, poor morale, and lack of engagement and ownership. These are the ingredients for injuries and you can't just eliminate one aspect, you need to address them all if you want to be proactive in reducing or eliminating injuries on the job site. This manual is a guide for accomplishing that.”
- “When organizations focus on planning with worker involvement, safety performance will improve. If you can control the environment and offer good ergonomic work conditions, safety performance will improve. This manual can help organizations be safe!”

Project’s Promotion of Prevention:

Explain how the results or outcomes of this project promote the prevention of workplace injuries, illnesses, and fatalities?

We expect that the Lean and Safety manual (the main product of the project) will contribute to accident prevention of electrical contractors (and other construction trades):

1. By sharing best practices for implementing lean tools and techniques to benefit worker safety that were developed and implemented by leading electrical and general contractors
2. By offering the manual that explains how to implement lean techniques and tools as a way to improve worker safety
3. By sharing innovative protocols/procedures that support the effective implementation of the developed manual for crew-level safety management
4. By showing a link and a way to achieve synergy between lean and safety

It is our long-term goal to achieve reduction in injury and fatality rates in the overall electrical industry for the next 10 years. In that regard, measuring outcomes in the short-term had to be mostly based on feedback that we collected upon the dissemination of the manual. As summarized earlier, the unequivocally positive feedback from industry practitioners has made us confident that the implementation of the manual will contribute to promoting the prevention of workplace injuries and fatalities.

Uses:

How might the products of your project be used within the target industry at the end of your project?

Is there potential for the product of the project to be used in other industries or with different target audiences?

A large number of contractors in Washington State claim that they actively apply lean techniques and tools for improving their projects, yet their applications are limited to design and construction operations. Given that lean techniques and tools have significant potential to improve worker safety, the Lean and Safety manual was developed by identifying and documenting best practices that effectively combine lean and safety. The manual is designed to serve as a step-by-step manual. Therefore, the practices and examples in the manual are expected support the efficient and cost-effective replication by electrical contractors that otherwise may not be able to afford to develop these practices from scratch. The dissemination of the manual to a broader industry in the state and nationwide will contribute to improving the overall worker safety of the construction industry as a whole, because construction companies in the US are increasingly interested in applying lean practices in recent years.

We anticipate that the Lean and Safety manual will also be beneficial for other industries including manufacturing, mining, transportation and warehousing, and healthcare industries. It should be noted that applications of lean principles in those industries have already become popular, so a significant level of synergy is expected when this manual is implemented for safety in any of those industries.

Organization Profile:

For awarded organizations, to include partners and collaborators, provide a brief description of each organization. Mission, vision, and purpose for each of the organizations who applied (this includes partners and collaborators) for the grant.

University of Washington

As a public flagship research university in Washington State, the primary mission of the University of Washington (UW) is to preserve, advance, and disseminate knowledge. The UW College of Built Environments (BE) strives to produce graduates who will lead the industry and contribute to the creation of smart inclusive communities; and to pursue research that addresses solutions to the issues of urbanism, globalism and sustainability. Within BE, the Construction Management Department aims to prepare individuals for careers in construction and related industries by providing high quality education, to conduct research that will benefit the construction industry, and to provide service to the community.

National Electrical Contractors Association

It is the mission of the NECA-Puget Sound Chapter to increase market share. NECA will organize, market, and provide a better-educated workforce. NECA is expanding its commercial, industrial, residential, maintenance, and new technology sectors. By being open and innovative, NECA will meet the needs of the market while maintaining the highest standards of quality and customer service.

Oregon State University

Oregon State University (OSU) is the state of Oregon's Land Grant university and a leading public research university. As the top research institute in Oregon, OSU aims to contribute to society's intellectual, cultural, spiritual, and economic progress and well-being through education, research, and service. The OSU College of Engineering endeavors to create solutions that promote strong economies, healthy people, and a sustainable natural environment. By emphasizing authentic, experiential engineering experiences within our curriculum, the College equips students with the knowledge, skills, and passion to advance innovative solutions to today's most complex engineering challenges. Within the College of Engineering, the School of Civil and Construction Engineering (CCE) provides a comprehensive state-of-the-art education to prepare students for professional and responsible engineering and constructor positions with business, industry, consulting firms, and government. The Construction Engineering Management program within CCE aims to advance knowledge and education in the field of construction to enhance safety, cost efficiency, productivity, and quality in the construction process.

Additional Information

Project Type ☒ Best Practice ☐ Technical Innovation ☐ Training and Education Development ☐ Event ☐ Intervention ☐ Research ☐ Return to Work ☐ Other (Explain):	Industry Classification (check industry(s) this project reached directly) ☐ 11 Agriculture, Forestry, Fishing and Hunting ☐ 21 Mining ☐ 22 Utilities ☒ 23 Construction ☐ 31-33 Manufacturing ☐ 42 Wholesale Trade ☐ 44-45 Retail Trade ☐ 48-49 Transportation and Warehousing ☐ 51 Information ☐ 52 Finance and Insurance ☐ 53 Real Estate and Rental and Leasing ☐ 54 Professional, Scientific, and Technical Services ☐ 55 Management of Companies and Enterprises ☐ 56 Administrative and Support and Waste Management and Remediation Services ☐ 61 Educational Services ☐ 62 Health Care and Social Assistance ☐ 71 Arts, Entertainment, and Recreation ☐ 72 Accommodation and Food Services ☐ 81 Other Services (except Public Administration) ☐ 92 Public Administration
Target Audience: General contractors, speciality contractors such as electrical contractors and mechanical contractors, safety managers, project managers, project engineers, superintendents, foremen, and construction management students.	
Languages: English	
Please provide the following information - (information may not apply to all projects)	
# classes/events:	5
# hours trained	
# students under 18	
# workers	200+
# companies represented	10+
# reached (if awareness activities)	500+
Total reached	8000+
List, by number above, industries that project products could potentially be applied to. 21, 31-33, 48-49, 56, 62,	
Potential impact (in number of persons or companies) after life of project? 3000+	
Have there been requests for project products from external sources? Yes If Yes, please indicate sources of requests: UW CM Alumni, AGC Member Companies in Washington and Oregon, NECA Member Companies, LCI Member Companies, MCA (Mechanical Contractors Association) Member Companies.	

PART II

Financial Information Budget Summary

Project Title:	Develop a Lean Practice Manual for Improving the Safety of Electrical Construction Workers		
Project #:	2017ZH00349	Report Date:	September 12, 2019
Contact Person:	Hyun Woo "Chris" Lee	Contact #:	206-616-4937
Start Date:	April 1, 2018	Completion Date:	June 30, 2019

1.	Total original budget for the project	\$ <u>149,827.00</u>
2.	Total original SHIP Grant Award	\$ <u>149,827.00</u>
3.	Total of SHIP Funds Used	\$ <u>149,827.00</u>
4.	Budget Modifications (= or - if applicable)	\$ <u>0.00</u>
5.	Total In-kind contributions	\$ <u>56,420.00</u>
6.	Total Expenditures (lines 3+4+5)	\$ <u>206,247.00</u>

Instructions:

- Complete the Supplemental Schedule (Budget) form first (on the next page).
- The final report must include all expenditures from date of completion of interim report through termination date of grant.
- Indicate period covered by report by specifying the inclusive dates.
- Report and itemize all expenditures during specified reporting period per the attached supplemental schedule.
- Forms must be signed by authorized person (see last page).
- Forward one copy of the report to **Grant Manager Name, SHIP Grant Manager at PO Box 44612, Olympia, WA 98504-4612**

PART II (Continued)

Financial Information

Supplemental Schedules (Budget)

Project Title:	Develop a Lean Practice Manual for Improving the Safety of Electrical Construction Workers		
Project #:	2017ZH00349	Report Date:	September 12, 2019
Contact Person:	Hyun Woo "Chris" Lee	Contact #:	206-616-4937
Total Awarded:	\$149,827.00		

ITEMIZED BUDGET: How were SHIP award funds used to achieve the purpose of your project?

	Budgeted for Project	Amount Paid Out	Difference
A. PERSONNEL	\$72,869.00	\$85,363.77	-\$12,494.77
Explanation for Difference and other relevant information: ? The development, publication, and dissemination of the manual turned out to be significantly time-consuming, which made the project members spend much more time than originally estimated. The difference was covered by transferring funds from the budget categories of Subcontractor, Travel, Publications, and Other.			

	Budgeted for Project	Amount Paid Out	Difference
B. SUBCONTRACTOR	\$34,951.00	\$34,106.38	\$844.62
Explanation for Difference and other relevant information: The remaining fund was transferred to the budget category of Personnel.			

	Budgeted for Project	Amount Paid Out	Difference
C. TRAVEL	\$6,382.00	\$2,583.17	\$3,798.83
Explanation for Difference and other relevant information: Travel distances were shorter than the original plan because most interviews and case studies occurred around the Seattle area. The remaining fund was transferred to the budget category of Personnel.			

	Budgeted for Project	Amount Paid Out	Difference
D. SUPPLIES	\$2,200.00	\$2,210.85	-\$10.85
Explanation for Difference and other relevant information: The difference was covered by transferring funds from the budget category of Publications.			

	Budgeted for Project	Amount Paid Out	Difference
E. PUBLICATIONS	\$15,150.00	\$10,173.88	\$4,976.12
Explanation for Difference and other relevant information: The production of manuals costed less than originally estimated. It was the original plan to publish 225 copies, but 1500 copies were made for less than the allocated budget. The remaining fund was transferred to the budget category of Personnel.			

	Budgeted for Project	Amount Paid Out	Difference
F. OTHER	\$3,600	\$713.95	\$2,886.05
Explanation for Difference and other relevant information: We originally expected that most meetings with contractors would happen during lunchtime. However, no			

interviews happened over lunch and the budget for meals was mostly used for the three Advisory Committee meetings. The remaining fund was transferred to the budget category of Personnel.

	Budgeted for Project	Amount Paid Out	Difference
TOTAL DIRECT COSTS	\$135,152.00	\$135,152.00	\$0.00
	Budgeted for Project	Amount Paid Out	Difference
TOTAL INDIRECT COSTS	\$14,675.00	\$14,675.00	\$0.00
	Budgeted for Project	Amount Paid Out	Difference
TOTAL SHIP BUDGET	\$149,827.00	\$149,827.00	\$0.00

	Budgeted for Project	Amount Paid Out	Difference
G. IN-KIND	\$52,959.00	\$56,420.00	-\$3,461.00
Explanation for Difference and other relevant information: The UW Construction Management Department provided cost-share support to cover the tuitions of Sadra Fardhosseini (UW Ph.D. Student) for three quarters, one quarter more than the original plan.			

I hereby certify that the expenditures listed on this report were made with my approval:

September 12, 2019

Date

Signature of Project Manager

PART III

Attachments:

Provide resources such as written material, training packages, or video/ audio tapes, curriculum information, etc. produced under the grant.

Also include copies of publications, news releases, curriculum, posters, brochures, etc.

The above information should also be provided on a CD or DVD for inclusion in the file.

- The PDF of the Lean and Safety manual is available from the link below:
<https://drive.google.com/file/d/1Ped6yBS5dGjki2NrDEUcb0VL5VSYevyx/view?usp=sharing>
- For users convenience, the forms introduced in the manual are available from the link below as Excel spreadsheets:
<https://drive.google.com/file/d/1EnI17EjyPpw-IXYSAA7gdaNoJ3AFDbiY/view?usp=sharing>
- 625 copies of manuals were delivered to the SHIP office on 6/22/2019.

REMINDER!!: All products produced, whether by the grantee or a subcontractor to the grantee, as a result of a SHIP grant are in the public domain and can not be copyrighted, patented, claimed as trade secrets, or otherwise restricted in any way.