

# Developing a Tool To Assess Workers' Understanding of Lean Concepts in Construction

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- ▶ Lean focuses on people, teams and partners making them able to change the way they think, behave and execute their work.
- ▶ Requires the implementation of the right tools accompanied with the presence of the right **culture**.

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- ▶ Construction workers have an indispensable participation in the construction process.
- ▶ While several studies focus on teaching lean construction to engineers, managers and students through trainings, games and workshops, few studies target construction workers on the topic of lean construction.
- ▶ The purpose of this study is to develop a tool to assess the workers understanding of lean concepts in construction.

Lean construction has contributed several benefits to the construction industry

-Increase in the client satisfaction

-Higher Quality  
-Better Value

-Decrease in the overall project cost  
-25% reduction in construction time

-Increase in the Reliability of planning and workflow

-Faster Response to Industry Conditions  
-Stable Employment Rates

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Lean construction has contributed several benefits to the construction industry

Lean construction mandates workers' active participation in the construction process

To be active they need to understand and know lean construction principles

However, we don't know if they possess this knowledge. And in case they don't, in what areas of lean construction concepts do they have weaknesses.

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## Assessment Tool

**Develop Lean Construction Worker Knowledge Profile**

**Assess the Current Knowledge Regarding Lean Concepts**

**Bridge the Gap in workers' understanding**

*Q1.* What knowledge should construction workers possess regarding lean construction?

*Q2.* What are the current weaknesses of the workers in understanding lean construction in the Lebanese construction industry?

*Q3.* What are the training programs to bridge the gap in their understanding?





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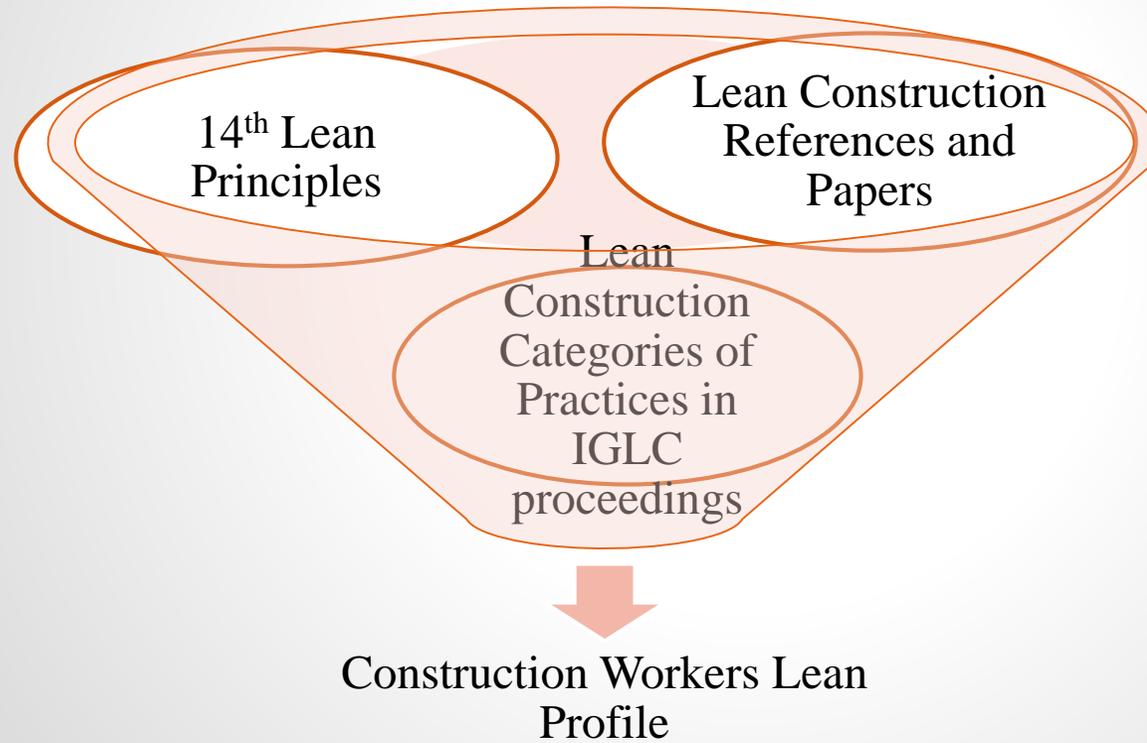
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## Develop a Lean Construction worker Knowledge Profile



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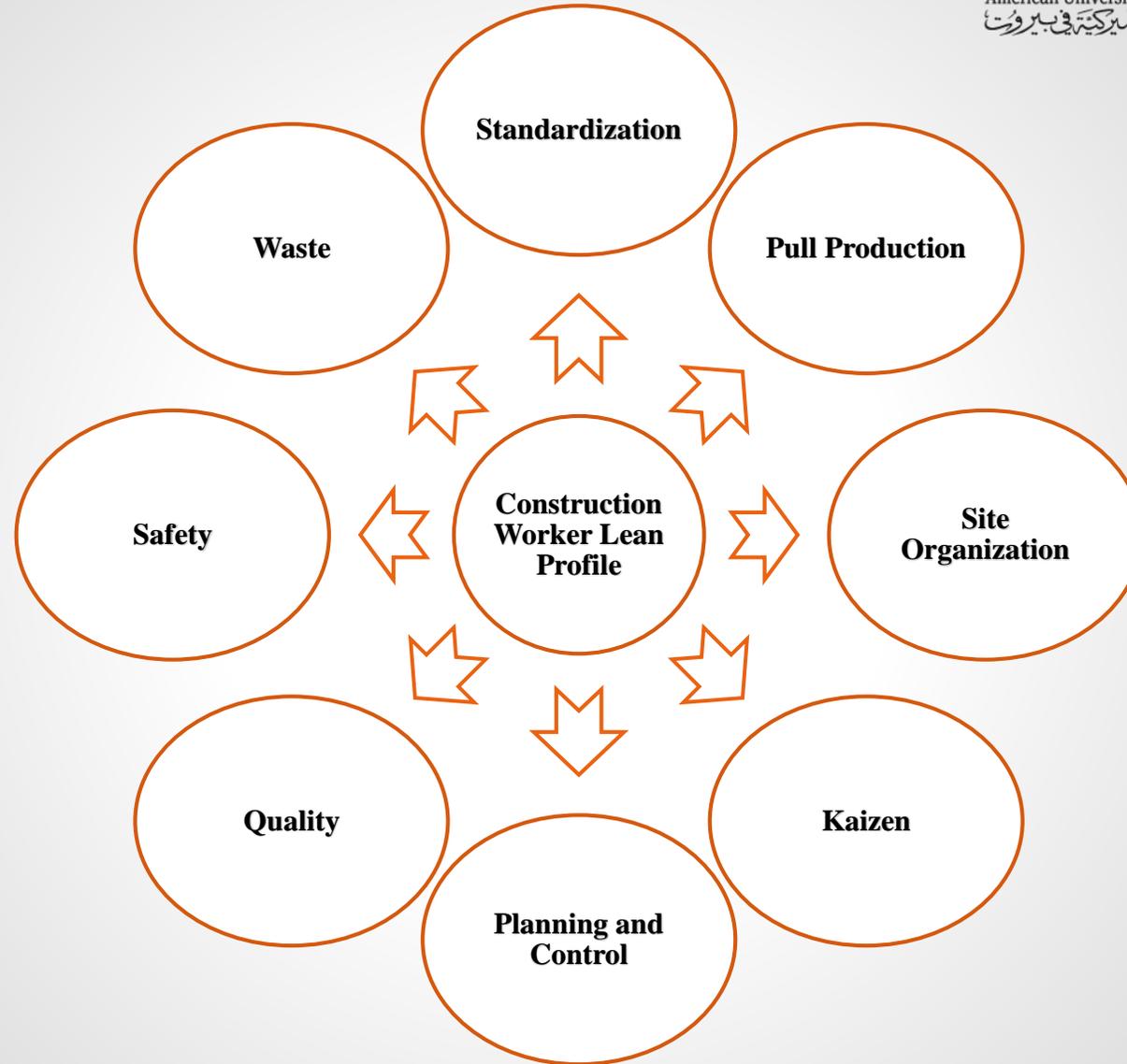
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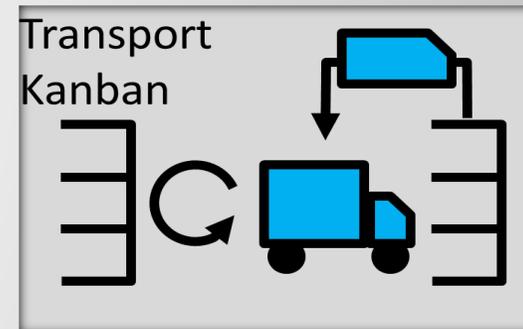
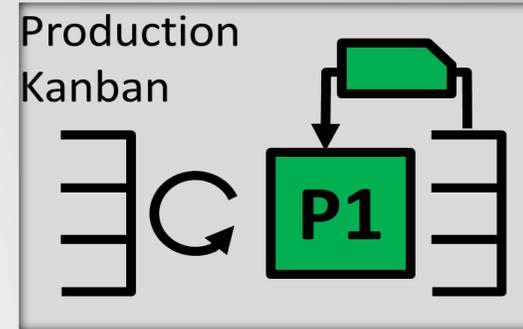
# STANDARDIZATION

- Keep only the needed tools, materials and resources in the work area (red tag area, trash)
- Put everything in its place and make a place for everything ( use tape ( outline areas, use peg boards)
- Mark the crane spots unloading bays, areas of work and the floor to highlight the walkways and location of tools and materials such that a safe and efficient working environment is established
- Color code the places by trade, traffic and material logistics plans
- Clean the tools and working areas when done or before
- Implement a task by following a standardized procedure
- Ensure, as a construction worker that you are following the standards through periodic self-evaluation
- Make shadow boards and use them to organize and ensure the availability of the tools



# PULL PRODUCTION

- Understand the sequence of tasks
- Realize the internal (successor) and the external customers (client/predecessor) of a process
- Provide the right products in the right place at the right time
- Make the processes transparent
- Understand the types of flow, materials , flow of information, crew, space,,,
- Understand and practice production-ordering- Kanban and transport/ supplier Kanban
- Know how to use the Kanban cards , production leveling Heijunka board, in station quality (jidoka) through Andon



(Arbulu et al.  
2003)  
(Koskela 2000)

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# WASTE



Understand and learn how to eliminate the types of wastes:

- Rework
- Unnecessary movement of workers on the construction site
- Unnecessary transportation of materials, equipment, tools
- Unnecessary processing of the work
- Making do (starting a task without its standard inputs or the execution of a task is continued where one of its inputs has ceased)
- Task diminishment (executing a task in a way that doesn't comply with the specifications)
- Defects produced from executing a task in the wrong way

In addition, they should know how to simplify processes by minimizing the number of steps to perform a certain task

Ohno 1988  
Kosekla 2004  
Patton 2013  
Koskela 2004

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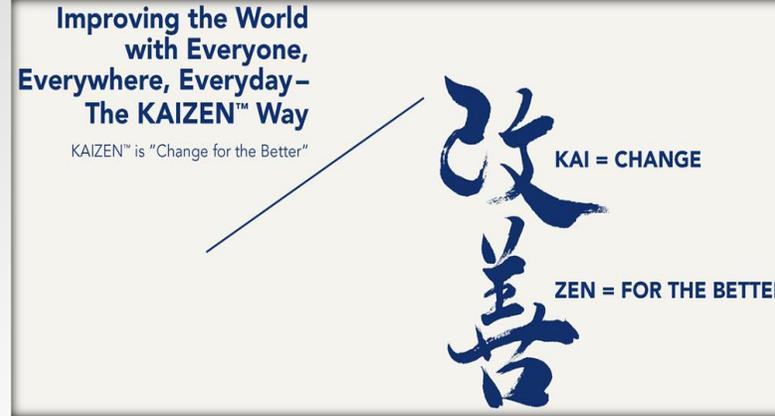
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## KAIZEN



- Reflect upon the root causes of a problem and take preventive measures to avoid its occurrence in the future
- Practice kaizen everyday through every work procedure done
- Make reliable promises
- Suggest new ideas about how to do my work, to improve safety, product quality , productivity or quality of work life
- Don't hide problems
- Ensure working as a team
- Ensure viewing the process and the result, not the result alone

(Hamzeh 2011)  
(Liker 2004)

## SITE ORGANIZATION

- Ensure that flow paths of people are properly marked, unobstructed, paved, flagged, protected and empty
- Ensure a clean and organized site with signs : place for inventory, jobs, technical room, warehouse, cafeteria, floor numbers, self-explaining signs
- Dedicate clear areas with signs for materials
- Gather small parts orderly in bins and at locations close to utilization
- Use signs for the materials in the stock with their corresponding quantities for replenishment



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## QUALITY



- Ensure quality right the first time even if it means to slow down or stop to enhance productivity on the long term
- Do in process-self inspection
- Ask 5 whys to understand the root causes of a problem
- Understand the regular quality control procedures for concrete, steel,....

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## SAFETY

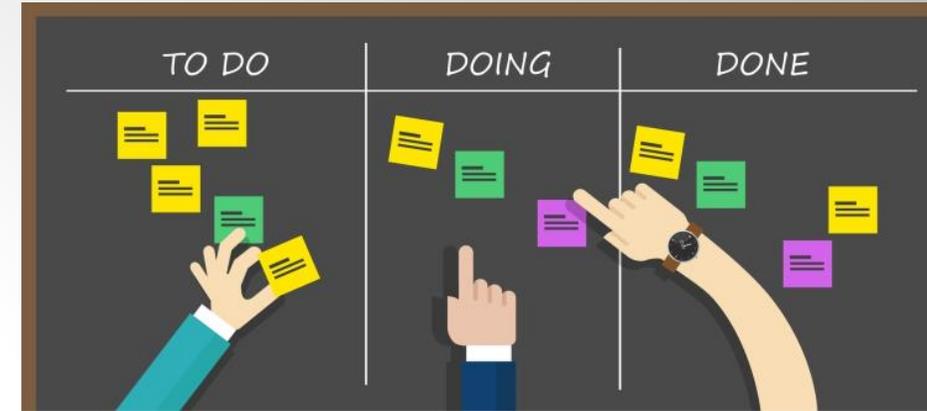


- Understand and practice safety signs and instructions and procedures in areas related to scaffolding, fall protection, excavations, ladders, head protection, electrical,... (as per the international safety and health requirement)
- Adequately use safety protection tools (helmet, glasses, protection shoes)....

(Bernstein and Jones (2013))

## PLANNING AND CONTROL

- Organize the daily work and put a plan to execute it
- Know the weekly work schedule
- Get involved in the planning of the work and the daily huddle meetings by giving my input, progress and problems while doing a certain task
- Define/ know the component of the product to be constructed as to content, timing, sequence, outcome, and describe the work to be done as shown in plans and specifications



## The Questionnaire

- ▶ Is based on the eight categories mentioned before
- ▶ Targets the previously simplified lean knowledge profile
- ▶ Aims to gather specific information about the way construction workers behave, execute and practice daily work



# The Questionnaire

- ▶ Uses a 7 Likert Scale
- ▶ It has 42 questions
- ▶ 73 professionals
- ▶ 7 Construction Projects

## LIKERT SCALE (7 points)



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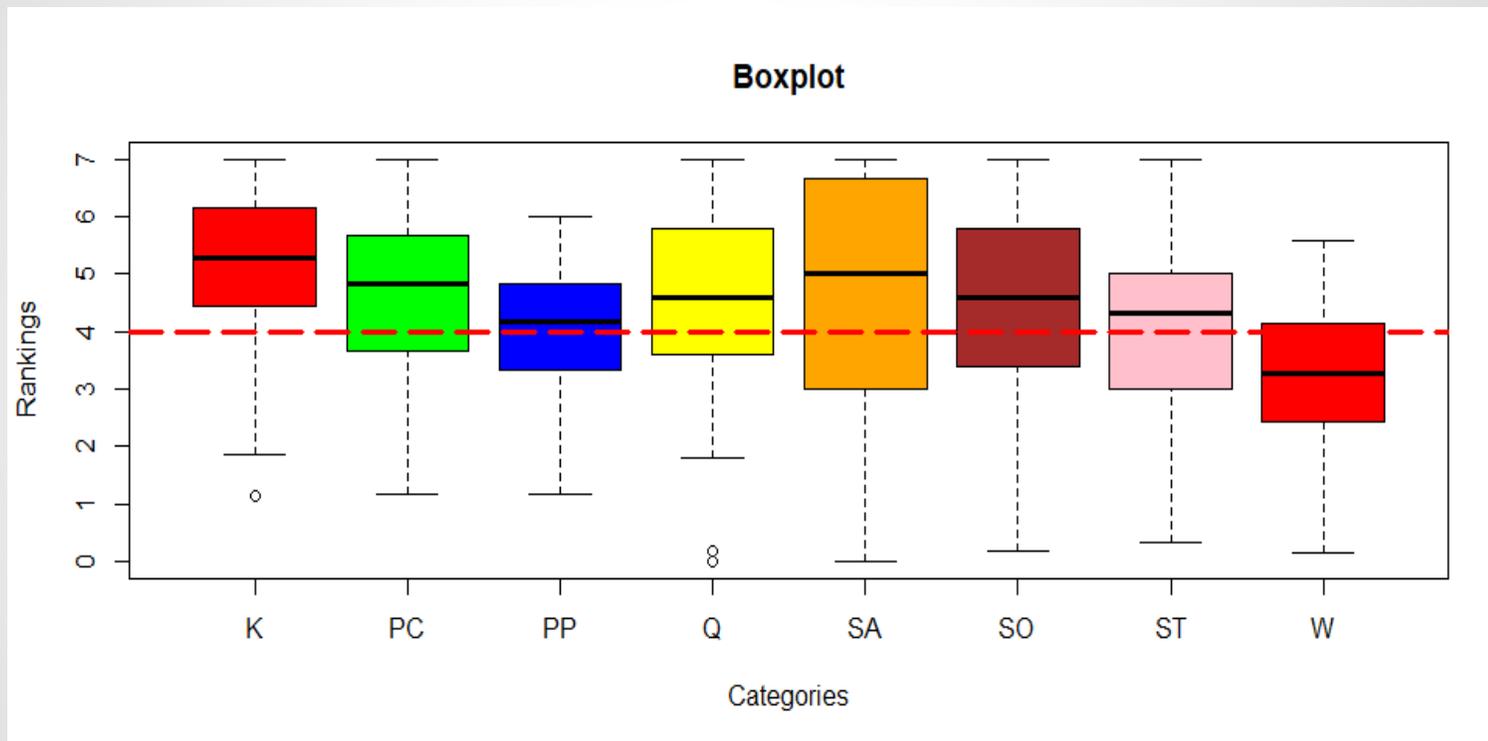
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# Results



Comparison between all the categories

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# Results



	Kaizen	Planning and control	Pull production	Quality	Safety	Site organization	Standardization
Planning and control	0.27786						
Pull production	6.2e-06	0.03445					
Quality	0.18319	1	0.34956				
Safety	1	1	0.46244	1			
Site organization	0.08037	1	0.52397	1	1		
Standardization	0.00046	0.37103	1	0.64305	0.64305	1	
Waste	3.4e-12	2.4e-7	0.00096	7.2e-7	0.00046	1.8e-5	0.00712

P-values for the Pairwise Wilcox Test

# Observations

- ▶ No training is given for construction workers
- ▶ Only general foremen in construction sites were trained to face safety related procedures, such as : fire hazards, emergency response trainings
- ▶ Construction workers might have heard about safety practices from the implementation of the ISO standards in certain companies.

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- ▶ Lack of understanding and applying waste related concepts and their types
- ▶ An absence of lean pull production knowledge
- ▶ Need better understanding of standardization, quality, safety, kaizen, site organization, and planning and control



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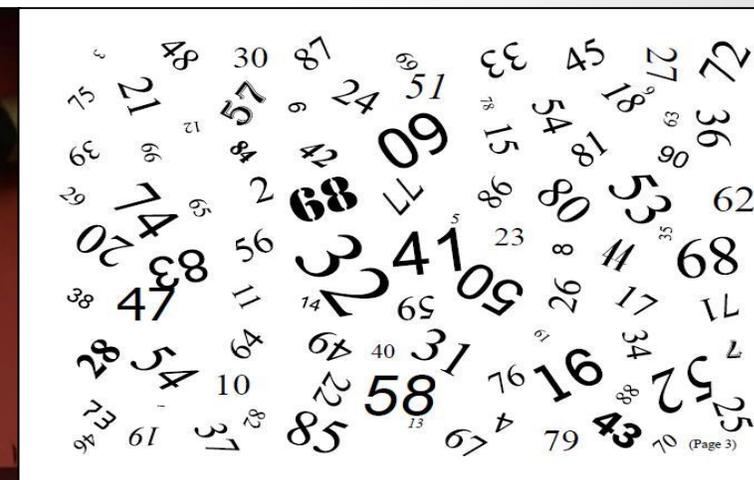
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## SITE ORGANIZATION

## WASTE

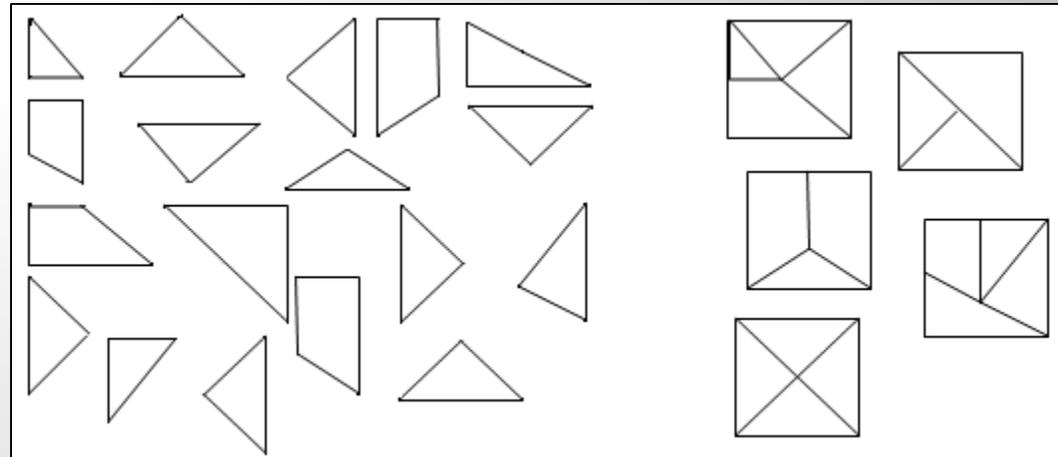
HOUSE OF CARDS	INFRAME GAME
STANDARD PIG GAME	LEAN APPARTMENT SIMULATION GAME
5S NUMBERS	LEAPCON
BALL GAME	



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KAIZEN
HOUSE OF CARDS
STANDARD PIG GAME
5S NUMBERS
BALL GAME
Dollar Game
Broken Squares
Airplane Game

STANDARDIZATION
STANDARD PIG GAME
LEAPCON
AIRPLANE GAME
VILLEGO
LEBSCO



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BALL GAME

DEMING'S RED BEAD GAME

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PARADE GAME

MAKE A CARD

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DICE GAME

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WIN AS MUCH AS YOU CAN

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# QUALITY

MAROON WHITE GAME

PAPER AIRPLANE GAME

LAST PLANNER DRIVEN GAME



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**RECOMMENDED**

- ▶ Skilled workers should be the ones to be given the training exercises and practices on the construction site who in return will give the training exercises for the other construction workers
- ▶ Construction workers who work in manufacturing construction related products such as aluminum works, doors should also undergo such lean trainings
- ▶ Skilled and trained construction workers become “role models” on the construction site

Thank You