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VISUAL MANAGEMENT STANDARD OF THE REINFORCEMENT STEEL PROCESS IN MEXICO.

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ABSTRACT

The importance of standardizing processes is one of the basic principles of "Lean" practices, it reduces the workload for the Construction Industry. It is important, particularly because of its artisanal process in Mexico. We can ask ourselves, how to adapt the standard with Visual Lean Management of a steel reinforcement work process that is used in Housing in the Construction Industry in Mexico? This attempt is still in its infancy, that is, the vast majority of the processes are not standardized. The studied process is based on the Mexican competency standard ECO-351-Manufacture of structural elements with reinforcing steel, as a spearhead to standardize the processes, of the concepts in general of the construction, to close the entire work cycle of the work, this article aims to highlight the importance and promote standardization, always seeking continuous improvement of the process by the user, but with a visual management approach (VM), so that production workers understand it faster and easier ; it was carried out through the cycle of continuous improvement of Deming (PDCA).

KEYWORDS

Standardization, Visual Management, Lean Construction, Continuous Improvement.

INTRODUCTION

Standardizing a work process with the idea of solving problems, based on the Continuous Improvement methodology, also known as the PDCA cycle, initiated by Shewart and later by Deming, is the main foundation of the Toyota philosophy, and the importance of VM Visual management to make the process transparent.

Two of the most important efforts that have been implemented to improve the construction industry are: construction without losses or "Lean Construction " and construction automation; however, one of the fundamental elements of the lean manufacturing system "Lean Production " is the Visual Management "Visual Management or VM" (Valente C., Brandalise , F., Viana, D. & Formoso C., 2018), which is an intrinsic part of the Toyota production model (Koskela,L ., Tezel , A., &

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Tzortzopoulos , P., 2018). According to Koskela et al., (2018), it is only recently that the academy has started with the creation of theoretical knowledge around visual, management, which until now derived from a practical evolution rather than from a theory. Housing construction in Mexico is one of the sectors with the highest production in the country, as a result of a recognized deficit in housing construction (CMIC, 2018), this construction sector is the fourth economic activity that generates wealth, contributing 7.4% to GDP in 2021 (first quarter) (CMIC, 2021)

Construction in general is noted for its low yields, lack of standardization, safety, high waste, low quality, modularity, high costs, among others, particularly in Mexico the construction industry is listed as the Industry with the most risk of work, established by the Mexican Social Security Institute (IMSS) in the Social Security Law, Work Risks Art. 73 and 74.

It is important to mention that Mexico has a great tendency to continue using labor, that is, building in an artisanal way, depending on the administrative personnel of the work (Corporal, Crew Chief, foreman, construction manager, or first command according to to the Regulation of the Law of Public Works and Related Services, superintendent, construction manager, front manager, resident) internal clients, and taking care of the satisfaction of the external client, which implies a valuable commitment of the people involved in the production, which generate a high impact on quality in execution, safety, cost, likewise, in the flow of processes through planning, continuity and monitoring of activities, to finish in a timely manner to optimize its management.

Construction works generally change from one project to another, with the exception of industrialized works, such as vertical and horizontal massive housing to mention an example, it is common for those in charge of the work (Manager, Administrator, superintendent, resident , etc.) according to their experience, academic degree and personality lead their own works, since companies in general allow them to do so, generating a wide variety of styles and forms in all construction processes, which is why the importance of standardizing work processes within the general construction cycle, seeking systematization and transparency with the lean approach. The ability to measure, understand, and manage variability is essential for effective project and process management (Ballard & Arbulu 2004). If there is no agreed standard, a new way of doing is simply one more version of some individual, and it is just practical (Lander & Liker 2007).

According to (Gadde and Hákansson, 2001; Samuelsson, 2006), a strategy to increase customer satisfaction in construction is to minimize uncertainty and increase the systematization of the construction process. This article answers the research questions:

How to adapt the standard with Visual Lean Management of a Steel Reinforcement work process used in Housing in the Construction Industry in Mexico? How to implement a Steel Reinforcement Standard in structure, as a pilot theoretical process with the Visual Management methodology and continuous improvement PDCA for Real Estate Promoters-Home Builders in Mexico?

The objective is to adapt and implement the standard in an way that is easy and simple to understand by the production personnel on site, supported by Visual Management (VM) of the lean construction methodology, of the standard used in Mexico, ECO-351-Armored elements structures with reinforcing steel", within the city, for residential buildings of up to 10 average levels and systematizing a theoretical pilot standard to promote all the concepts of the work cycle of a construction.

CONTEXT IN MEXICO

If we add to this the lack of some supplies of standardized materials that comply with established standards, in the case of Mexico there are three: **Mexican Official Standard (NOM)** is a technical regulation of mandatory observance, the legal framework that regulates the expedition and its compliance is the *Federal Law on Metrology and Standardization* published on 07/01/1992 in the Official Gazette of the Federation (DOF), the other is the **Mexican Standard (NMX),** a reference instrument to determine the quality of products and services. . They are prepared for public use by a national standardization body or the Ministry of Economy, their objective is to protect and guide consumers, they are not mandatory, their compliance is voluntary, but if it refers to an NMX, it will be mandatory, the third is **Reference Standards (NRF)** are prepared by the public administration. The legal framework is established in the Agreement on Technical Barriers to Trade (AOTC), as well as in the Federal Law of Metrology and Standardization (LFMN) and its Regulations.

A standard of materials and of the proposed process we have the Information References ·NMX-C-407-ONNCCE-2001 Construction Industry-Corrugated Steel Rod from ingot and billet for concrete reinforcement.- Specifications and Test Methods.

A fundamental principle of the 1944 International Labor Organization (ILO) Declaration of Philadelphia is that labor is not a commodity; meaning that workers should not be treated as a factor of production or subject to the same market forces that apply to commodities. The vulnerability of workers and the need to protect their basic rights is reflected in the "Universal Declaration of Human Rights and in the International Covenant on Economic, Social and Cultural Rights".

The National Council for Standardization and Certification of Labor Competencies (CONOCER) recognizes the knowledge, abilities, skills and attitudes of people, acquired at work or throughout their lives, with national and official certifications, is committed to increasing efficiency and effectiveness of the internal operating process; to satisfy the requirements and needs concerning the standardization and certification of labor competencies; In accordance with Mexican laws, the applicable regulations and the continuous improvement of the Quality Management System, there are competency standards (EC) in Construction.

STANDARDIZATION

Currently in Construction of Civil Engineering Works, they are particularly for management and administration processes, in subsector 236 Building there is the **ECO-351 standard** -Assembly of structural elements with steel reinforcement oriented to people who must have knowledge, abilities, skills and attitudes to perform in the assembly of structural elements with reinforcing steel, published on October 5, 2013, and developed by the Mexican Chamber of the Construction Industry, the purpose of the Competence Standard is to serve as a reference for the evaluation and certification of the people who work **assembling structural elements with steel reinforcement** . The **Competence Standard** establishes the critical functions that an iron officer must perform for quality work, these functions are: Carry out work prior to assembly, for which the identification of supplies is carried out to start the assembly work , **enable** the material, and prepare the list of supplies to be used in the **assembly** ; on the other hand, place the reinforcing steel in the structural element; For this, the element is drawn and the respective ties are made

to the reinforcing steel rods of the structural element according to what is specified in the project; which will be taken as a basis for the proposed process with a Visual Management approach as a contribution.

PROCESS MAPPING

To identify the correct process and its implementation of the Steel Standard for steel reinforcement in PDCA structure with Visual Management and for Real Estate Promoter-constructor of housing in Mexico, **the process was mapped** with a SIPOC diagram as a tool of the structure or flow of research and documentation, to visually analyze and manage the problem of the standard, with an assertive visual description to achieve the objective, achieving the division of the investigation over time, or the first step for the implementation of a lean construction system, seeking to reduce the variability of the processes, trying to eliminate or reduce inefficiencies or recurring waste.

It is important to mention that visual management is the essential part of the Toyota Production System (TPS) and has a key role in creating transparency (Liker, 1997; Formoso et al., 2002). Generally, communication and transparency problems are evident in the application of planning and control in construction based on Lean concepts, such as the Last planner System (Alarcon & Conte, 2003; AlSehaimi et al., 2009; Kalsaas et al., 2009).

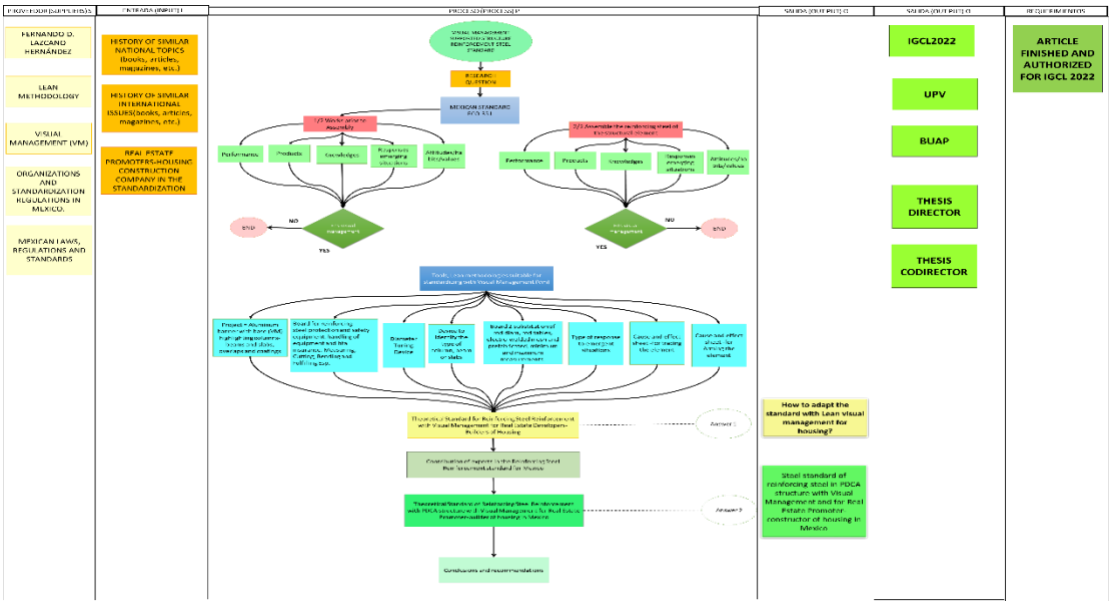

Figure 1 SIPOC Diagram of the Steel Standard for reinforcing steel in PDCA structure with Visual Management. (own source and tabular format Lean-Inn.com)

A common expression at Toyota is “We don't just make cars; we make people”. Every new product development program, every prototype, every quality defect in the factory, every kaizen (Japanese term for continuous improvement) **is an opportunity to develop people** (Liker, 1997).

If there is no transparency of information between planning and execution, it makes it difficult to identify problems before execution (Koskela & Howell, 2001). One of the techniques to implement improvement actions are the Deming cycles or also known as cycles. PDCA (Plan-Do- Check - Act), is a continuous improvement cycle, based on a scientific method, to implement change or standardize a process, to measure and control

it, with the main idea of carrying out adjustments, improvements or relevant actions (Pons & Rubio, 2019).

With the support of the process mapping of the following Figure No. 3, the research process was mapped graphically to be competent, it must demonstrate certain criteria such as Performance, Products, Knowledge, response to emerging situations in addition to complying with habits, values and attitudes.

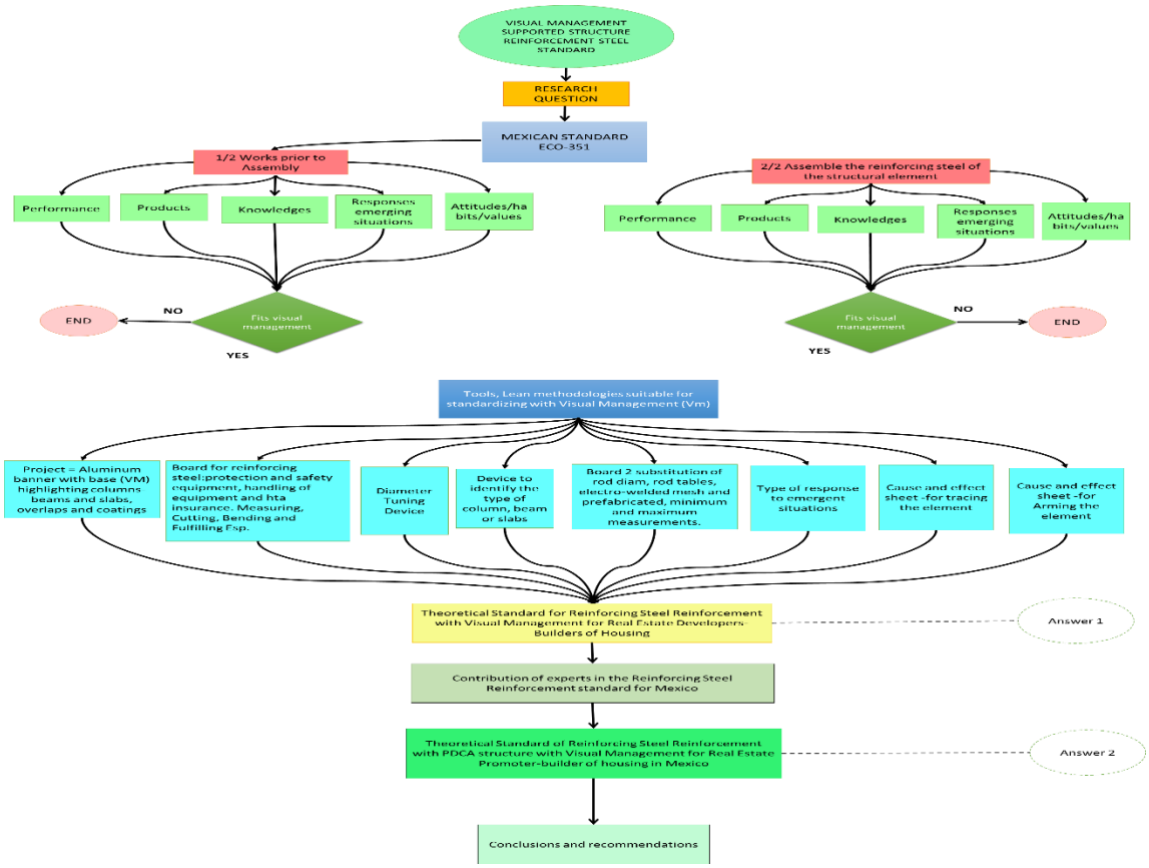

Figure 2 Mapping of the research process in graphic form. (Own source)

Once the competencies of the standard have been determined, we are going to establish the support tool, or Lean Visual Management (VM) methodology, a greater standardization in construction is suggested, to identify the causes of production problems, establishing and systematizing routines greater efficiency and thus easier process control for site administrators (Ungan, 2006).

In addition to Liker, Höök (2008) found that standardizing processes is predictable and essential if a Lean culture is to be pursued. Gibb and Isack, (2001) found that standardization minimizes cost, generating a positive impact on the processes within the general cycle.

Based on the research, we are going to establish the criteria that must be met to be competent in the standard, but with the innovation of being supported with adequate Visual Management tools or methodologies for a better understanding; easily and simply by the staff, from production to work, always seeking the development and growth of people.

In order to be competent in the standard, we are going to develop, in the first instance, the initial PDCA that meets the aforementioned characteristics.

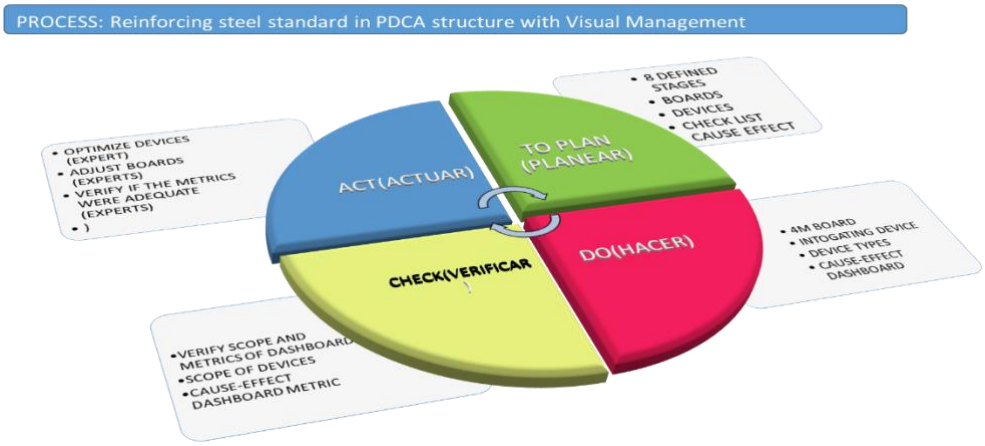

Figure 3 PDCA Continuous Improvement Cycle of the standard research process in graphic form. (Own source)

Seeking continuous improvement and innovation, trying to change the way of thinking, acting and learning collectively and individually with a common goal, think of the cycle of continuous improvement of people as a system:

1.- Standardization as support: Visual management need to create Dashboards, devices and check list.

2.- Create a system of boards, devices and checklist lean visuals that meet the SMART concept, that is, they are specific, measurable, achievable, realistic and timed to generate key metrics.

3.- Verify the scope and metrics of dashboards and devices, Adapt or modify dashboards and devices seeking excellence through continuous improvement.

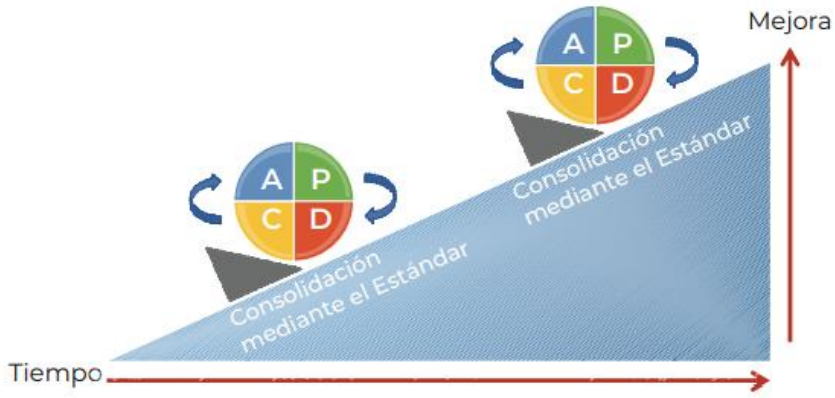

Figure 4 According to the KAIZEN philosophy, each PDCA that we carry out is considered as a starting point to do a better job. Source: (Pons & Rubio, 2019).

The previous figure represents the objective of the process of the improvement cycle flow continues to seek excellence of people and the organization, systematizing and improving

processes seeking its practice in lean construction, as a watershed to standardize the entire cycle of improvement processes of work in a construction.

VISUAL MANAGEMENT IN STANDARDIZATION

The information exchange process can be verbal (written or oral communication), nonverbal (eg, body language, facial expression, tone of voice, etc.), or visual (sensory) (Wood, 2009). Let's remember the famous saying: "a picture is worth a thousand words" is not in vain. Or the classic phrases that we say "You have to see it to believe it", or when a person says "It is clear to see", or that Mexican phrase "It is clearer than water", they are expressing that this idea involves reality in an image, transparently. Why does a curve shown on a graph look more real than a departmental memo? (Greif, 1989). The standard is implemented with Visual Lean Management for homes, analyzing in the first instance, the first board that must respond to the following processes:

Evaluation criteria: The person is competent when they demonstrate the following:
With two elements of competency:
Title: **Carry out work prior to assembly - Evaluation criteria**

Devices: 1.-Flag of plans, highlighting: **Identifies the element to be built:** Marking with color on the plan/sketch/work order, also physically locating it in the work front, *by levels and verifying its update by last modification on date, verifying its belonging in situ. 2.- To accommodate the reinforcing steel* by diameter and with the implementation of a quantity control flag.

Figure 5 Device No1. Plan flags identifying the plans, their latest modifications, by levels, floors and sections; Device No2. To accommodate reinforcing steel by diameter and with the implementation of a quantity control flag, source: (Ohra , TodoArt , Own)

Enables the material for reinforcing steel reinforcement: *Board No. 1 previous work: indicating form of accommodation and validating personal protective equipment, with operation safety measures, materials and necessary equipment, and the three*

performances that must be met: measure, cut, fold, in addition to attitudes, habits and values.

Figure 6 Board No.1: Reinforcement of structural elements with reinforcing steel- Previous Works, source: (OHRA, CISMA and Own)

In addition, it is complemented by Board No.2: Arming of structural elements with reinforcing steel: Organization of equipment and materials; with the objective of identifying and placing the stirrups of all the structural elements, dice, counter beams, columns, beams and others, likewise, the annealed wire cuts for use in the mooring of the different rod diameters.

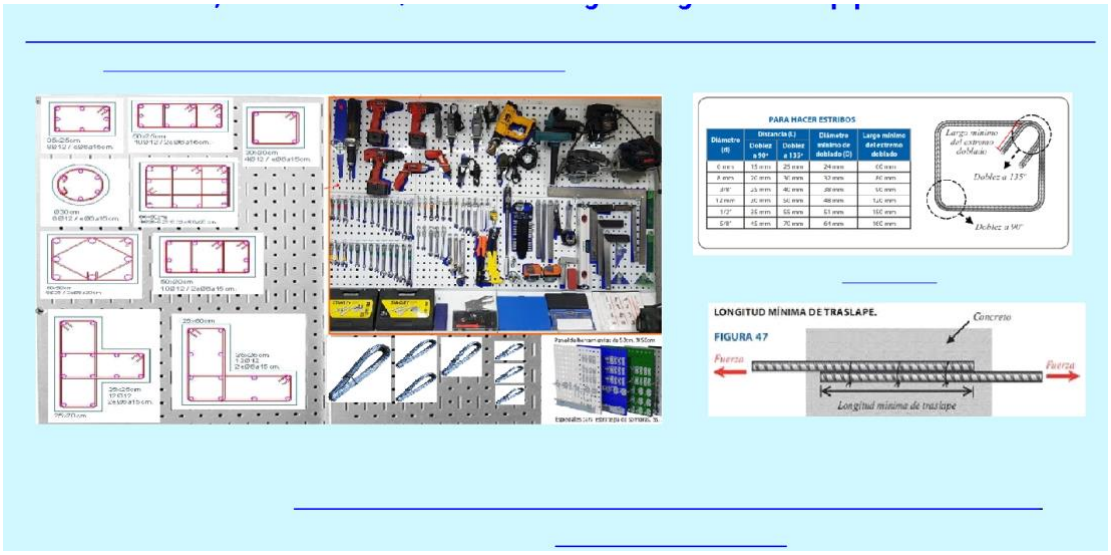

Figure 7 Board No.2: Reinforcement of structural elements with reinforcing steel Organization of equipment and materials, source: (Own with internet images)

The person is competent when he/she obtains the following: Products and Knowledge: *They identify with the device No 1 and Board 1 and 2,* quantities and characteristics, specified of the assembly and the work area, identify materials, tools and

necessary equipment and verify in the *DYNAMIC BOARD No 3 COVERING IN CM ACCORDING TO CONCRETE CHARACTERISTICS and elements* , which when identifying the window or button you can select, if it is for concrete made manually or premixed, in the same way in *the DYNAMIC BOARD No. 4 SUBSTITUTION OF RODS*, similarly, it identifies the window and you select the required diameter and it generates the number of rods necessary for the replacement by the steel area, see attached tables.

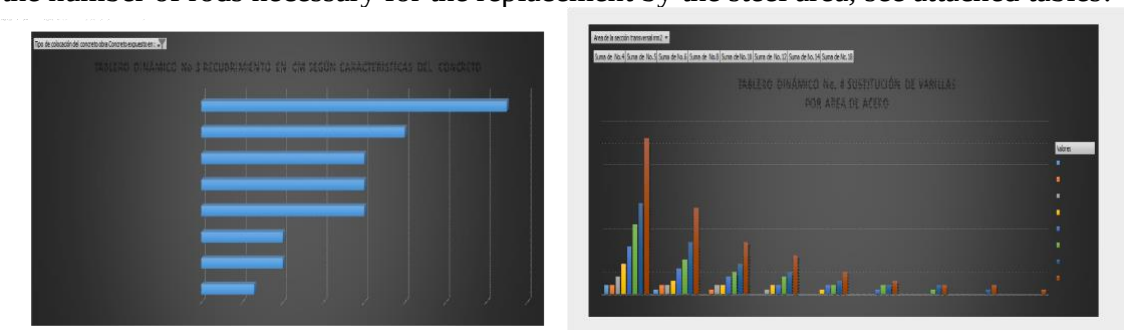

Figure 8 Dynamic Board No 3 Coverage in cm according to the characteristics of the concrete. (source: NMX-C-407-ONNCCE-2001), Dynamic Board No. 4 Substitution of rods per steel area. (source: NMX-C-407-ONNCCE-2001).

Regarding reference 2 **Arm the reinforcing steel of the structural element** , **Evaluation criteria,** With a visual support type check list with metric of whether it complies or not, it is verified before, during and at the end of the standardized process of the sketch in the work (gemba), the trace identifying the element and its setting out in situ (gemba) and times, coatings established according to the project and specifications, what the reinforcement of the steel specified in the project and common practice in the work (gemba) must meet, identifying in a simple and easy visual way what the proposed standard must meet, this is one of the relevance of the investigation.

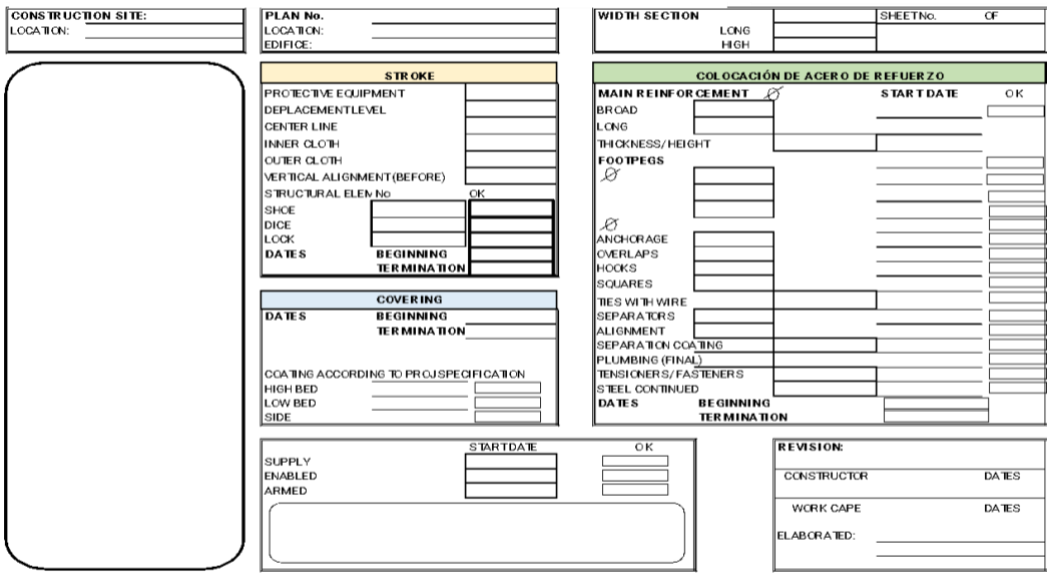

Figure 9 Check list: reinforcement control in reinforcement steel elements

The process was not theoretical when crossing the opinions of two Civil Engineers in charge of Construction Superintendents and a Reinforcing Steel Contractor Industrial

Engineer, generating feedback, in addition to production personnel, a construction manager and two iron officers who gave their points of view, and that they like it visually, currently the standard does not consider this checklist of the real process in the work. In this way we answer the second research question, integrating in 3 Boards the "Standard of reinforcing steel in PDCA structure with Visual Management and for Real Estate Promoter-constructor of housing in Mexico, as shown in the following figures:

Figure 10 "Standard of Reinforcing Steel in PDCA Structure with Visual Management and for Real Estate Promoter-constructor of housing in Mexico.

CONCLUSIONS:

Boards 1 and 2 are for visual support on the construction site, where they normally enable the steel, as well as dynamic boards 3 and 4, with the exception that a device such as an iPod or cell phone that has Excel will be able to select the appropriate coating. and the replacement of rods according to the stock they have on site, or due to a special need, complementing the checklist (check List), according to the "Lean" philosophy, go to the production site called (Gemba) which is the work, as a contribution to the investigation if it is executed and complies, generating a metric that seeks continuous improvement, otherwise what is necessary to comply is executed, which is a great contribution to our field workers, as well as for their personal growth and a visual aid to verify what to consider, as a support to helpers to grow in their knowledge and to shorten their learning curve Even when there are articles as background to the subject, we must highlight the heading of Principle 6 in " The Toyota Way " that states: "Standardized tasks are the basis for continuous improvement and empowerment of employees" (Liker , 2004), no research touches on the subject from the Visual Management approach, some authors stand out as (Rybkowski , 2014), focused on documenting the methods and expected results in a simulation that illustrates the productivity of collective Kaizen , (Polesie , 2009) in interviews identified that it is difficult to implement due to the lack of teamwork between senior management and field management, in the case of (Aapaoja , 2014) reveals the main challenges for process standardization is difficult, processes should be focused on standardizing and modulating them, confirming that this research has a different approach to address the issue. It is a contribution thinking of the production staff, looking for teamwork and for them to take ownership of the process, to find a way to adapt it, to adapt it looking for Continuous Improvement.

Addressing new research questions, such as: In what other construction processes can standardization be generated with Visual Management? Can Visual Management be applied in other countries? generating new research opportunities.

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