

# MECHANISM FOR INTRODUCING LEAN CONSTRUCTION PROJECT MANAGEMENT PRINCIPLES AND CONCEPTS THROUGH SELF-DIRECTED LEARNING

Christy P. Gomez<sup>1</sup> and Siti Fazreena Idayu Bahtiar<sup>2</sup>

## ABSTRACT

Approaches to introducing lean construction principles and concepts have been, in the main, inconsistent with the learning theories and their learning modes. Additionally, these approaches have been found to be lacking in terms of being practice-specific whilst not addressing the potential to be systemically implemented. This paper describes an attempt to address these issues. A pilot Lean Construction Management Learning Programme (LCMLP) is currently being developed with a collaborative industry partner as a mechanism for implementing Lean Construction principles and concepts in a systemic manner within the management community of a construction project whilst addressing the key issue of conceptual change that focuses on the necessary learning modes. The approach is a collaborative longitudinal management research and development (R&D) project, viewed as a form of Management Learning Practice. This programme is aligned with the andragogy model of education focused on self-directed learning in a situated context. The Programme is structured according to the key fields of Design Management, Production Management and Supply Chain Management focused on minimizing waste and maximizing value.

## KEY WORDS

lean construction, management learning, action learning, social learning, construction management

## INTRODUCTION

The role of institutionalised and formal learning in the field of construction management is still very much focused on traditional concepts and principles of construction project management with a general predisposition towards individual learning theory.

Additionally, the current developments in the field of construction management receive scant attention and are often only explored by individual students in their final year projects, whilst postgraduate students are inclined to deliver outcomes featuring studies that are often of the general management genre, lacking

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<sup>1</sup> Lecturer, Department of Construction and Property Management, University Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor, Malaysia. PH: (+6)07-453 7193; FAX: (+6)07-453 6021; email: cpgomez@uthm.edu.my

<sup>2</sup> Masters Student, Department of Construction and Property Management, University Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor, Malaysia. PH: (+6)07-453 7193; FAX: (+6)07-4536021; email: fazreenaidayu@yahoo.com

foundational challenges. The degree to which management research undertaken is having a credible influence on practice is very negligible (Keep, E., 2004). This is evidenced by the numerous efforts undertaken to impose regulatory requirements or undertake incentive-driven approaches for implementing 'new' initiatives in the construction industry. Thus, it is not surprising that the management workforce in the construction industry are lacking knowledge of current developments in management research within the industry.

#### **IT-ENABLED SELF-DIRECTED LEARNING TOOL FOR ENABLING LEAN CONSTRUCTION PRACTICE**

It has been noted by Hirota and Formoso (1998), that it is important to recognize that ignorance about the learning process can prevent communication of new ideas. This is recognized specifically in the context of the necessity to develop construction managers education aimed at incorporating lean production concepts and approaches in their daily practice. This paper describes an attempt to address the issue of having to systemically introduce Lean Construction Practice (LCP) through self-directed learning that is based on Traditional Cognitive Theory (TCT)/Constructivist Theory (CT).

The ontological framework of the LCMLP is structured on three fundamental modes of learning: (i) Individual learning (ii) Organizational learning (iii) Learning by doing. Hence, the three modules presented for each field (i.e. Design, Supply Chain and Production) are structured based on these primary approaches.

Additionally, taking into account that conceptual change requires addressing the issue of prior knowledge (see Tyson et. al., 1997), and this can be addressed through engaging in Problem-based learning (PBL). Finally, ensuring that knowledge is shared, and the complex concepts can be fully understood within communities of practice; a third mode of learning viewed as Action Learning (AL) 'structured' as Action Learning SETS based on community of practitioners involved in a specific workflow engage in implementing LCP (Pedler, M., 1997).

Primarily, the approach is structured as a Lean Construction Management Learning Programme (LCMLP) that is aligned with the andragogy model of education. The view taken here is that adults are self-directed and expect to take responsibility for decisions. Andragogy makes the following assumptions about the design of learning (Knowles, M., 1984):

- Adults need to know why they need to learn something;
- Adults need to learn experientially;
- Adults approach learning as problem-solving, and
- Adults learn best when the topic is of immediate value.

However, the degree to which any approach constitutes the undertaking of the learning process varies according to the strategy for learning of the complex practice-related phenomena (see Table 1). The LCMLP is labeled as the Lean CoM<sup>2</sup> Toolkit.

Table 1: Framework of LCMLP – Towards a Flow View of the Learning Process

FIELDS	FOCUS ON LEARNING STRATEGY OF LCMLP		
DESIGN/SCM/ PRODUCTION	INDIVIDUAL LEARNING	ORGANIZATIONAL LEARNING	LEARNING BY DOING
MODULE 1			
MODULE 2			
MODULE 3			
	Based on Cognitive/Constructionist Learning Theory	Based on Collaborative/Social Learning Theory	Based on Action Learning/Experiential Learning Theory

## THE LEAN COM<sup>2</sup> TOOLKIT

The Lean CoM<sup>2</sup> Toolkit consists of a Lean Intro section, and the three fields of Design, Supply Chain Management and Production Management (see Figure 1). Each field consists of three modules. The first module is an online self-directed learning package, which is wholly based on cognitive/constructivist learning and facilitated by Lean Construction Management (LCM) practitioners/researchers. The second

is a module structured as a Problem Based Learning (PBL) Experience that is oriented towards Social Learning Theory in order to develop a shared experience of learning new concepts. The PBL experience is based on utilizing an approach titled FILA; focusing on the facts of a problem situation identified by practitioners to be highly wasteful, working in groups on the ideas to resolve the issue, noting the learning issues and identifying the modes of action for achieving higher value (see Wee, K.N.L., 2004).

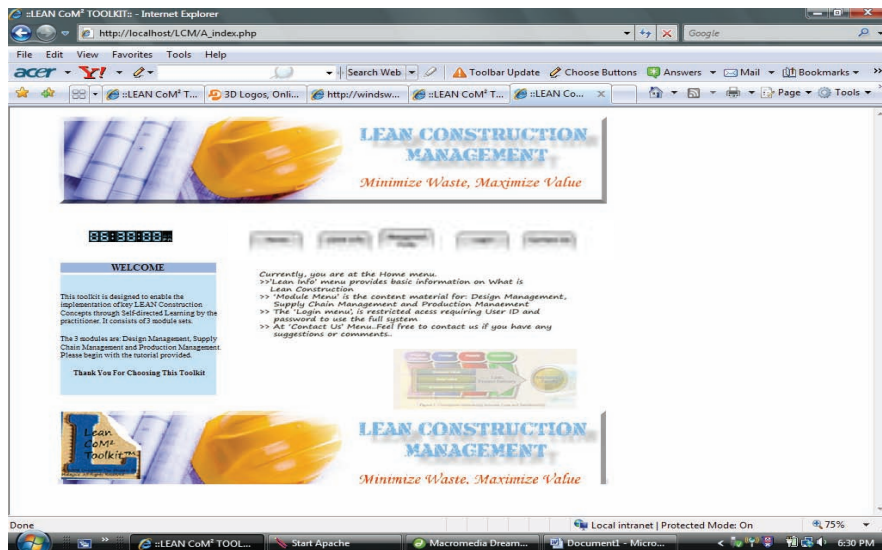


Figure 1 : Lean Com2 Toolkit Main Interface

The final module is structured as an Action Learning (AL) package that has a generative content that can enable the actual change in undertaking the planning of the project utilizing Lean Construction Management principles and concepts focused on the actual groups working as AL SETS. In all 3 modules, the emphasis is to focus on Value Stream Mapping to analyze the work flow and material flow, whilst applying the principles of Commitment Planning, Lookahead Planning, Just-in-Time in order to achieve Planned 100% Complete (P100C).

#### LEAN INTRO

This provides some basic information on "What is Lean". The main content describes work structuring and provides an option to do Work Structuring (WS) based on specific work to be undertaken for a week. WS is the breakdown of both product and process into lots, sequences and assignments so that work can flow smoother, with less variability thus reducing waste and increasing value. The approach is differentiated from the conventional approach of breaking down work according to work packages that are based on specific sub-contracts as is often referred to as the Work Breakdown Structure (WBS).

The web-based function is structured using HTML (Dreamweaver), PHP, Java script and flash. It contains 5 menus that are 'Home', 'Lean Info', 'Modules', 'Login' and 'Contact Us' Menu. The Home, Lean Info and Contact Us menu contains brief information related to the toolkit. The main content is within the *Modules Menu* which consists of

an interactive tutorial for the 3 modules: Lean Design Management, Lean Supply Management and Lean Production Management. Whilst, the Login Menu is the option for access to the Central VAit-MAS Toolbox which is a Multi-Agent System (MAS) for "real-time construction management".

#### LEAN DESIGN MANAGEMENT MODULE

This is structured as a self-directed learning experience. Self-directed learning is seen as any study form in which individuals have primary responsibility for planning, implementing and even evaluating the effort. This self-directed learning module, initially consists of examples to work on generic considerations or applications for using set based design techniques. It has been identified by Parrish et. al., (2007) that set-based design makes it possible to maintain feasible options for longer periods compared to the common practice using point-based design. The emphasis on using set-based design is to reduce cumulative over-design and avoid rework through teamwork. An example (see Figure 2) consisting of the typical scenario involved when faced with designing a simply supported concrete reinforced beam is provided. A database of the relevant alternative design cases is provided (see Figure 3). Additionally, the user is allowed to identify the essential criteria or requirements (see Figure 4) that are critical to decision-making that links to the possible cases such that the best option is chosen in order to minimize waste and maximize value.

The user is then prompted to provide problem-settings relevant to (a) Reducing Waste and (b) Maximizing Value, based on their planned work assignments. These are



brought forward at the follow-up group problem-based learning (PBL) session. At this PBL session a Facts, Ideas, Learning Issues and Action Plans (FILIA) approach is used facilitated by the RT ( see Wee, K.N.L., 2004) with a view to planning the design work by visualizing the 6-week Lookahead Planning to ensure Planned 100%

Complete that utilizes the Last Planner System (LPS). The Action Learning Module fundamentally consists of focusing on the particular work process by the PBL group and undertaking the actual design based on having structured the work process for delivering the product based on “pull scheduling”.

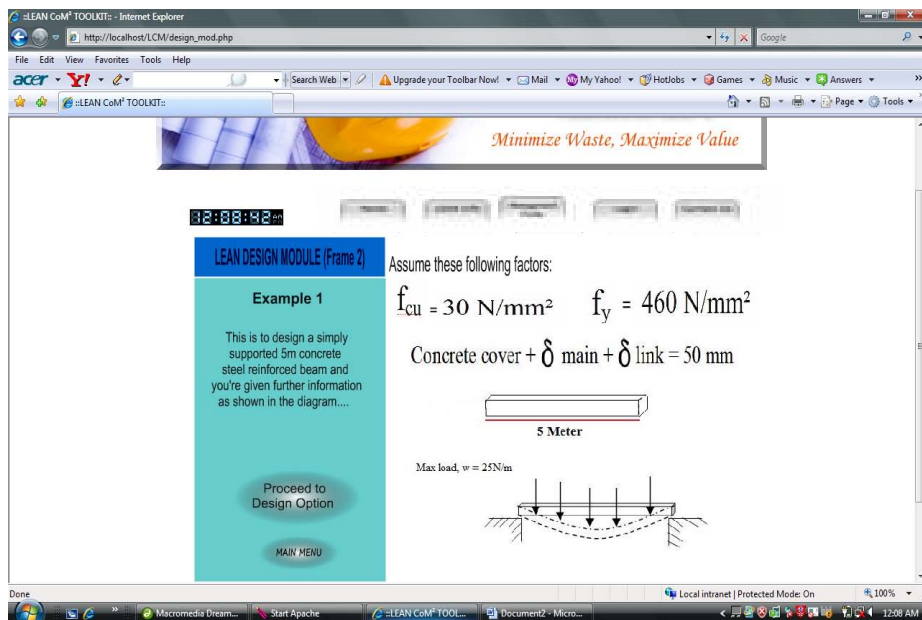


Figure 2 : Lean Design Management Frame 2

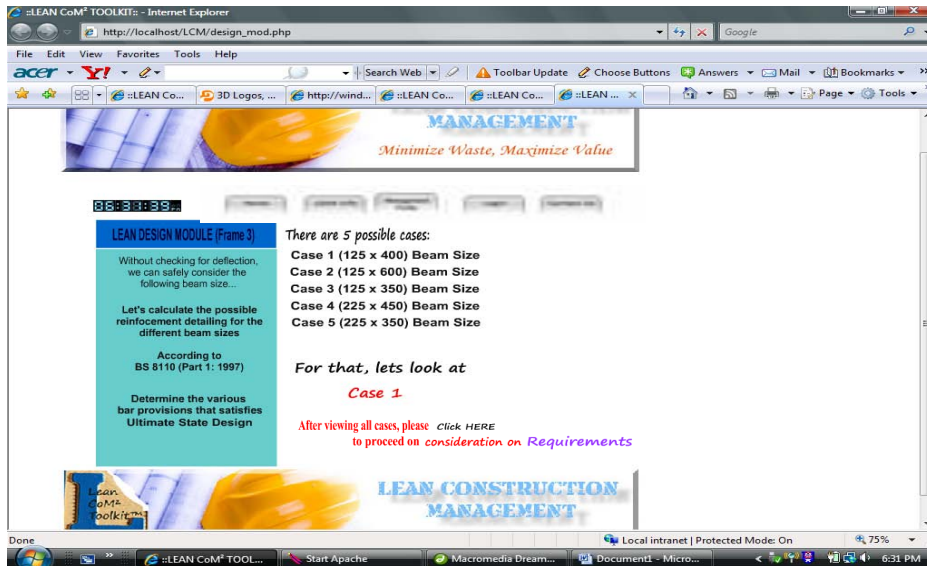


Figure 3 : Lean Design Management Frame 3

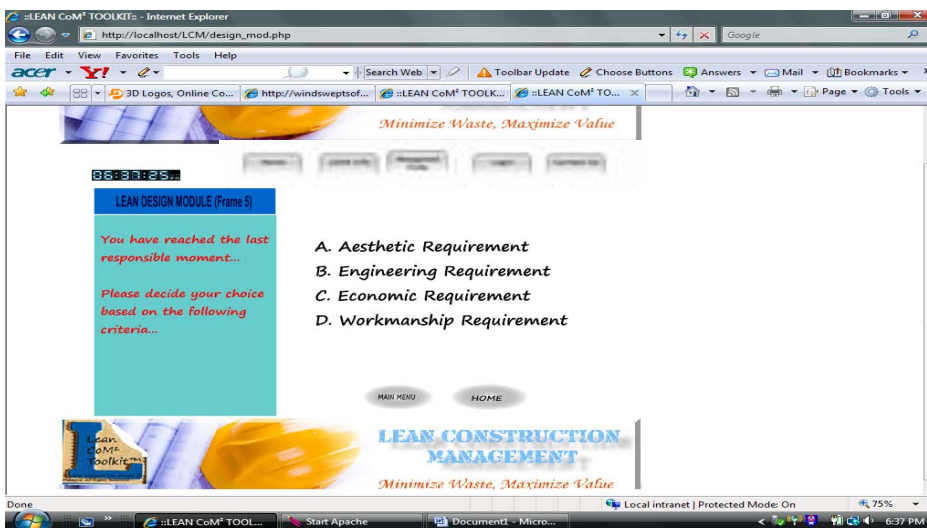


Figure 4 : Lean Design Management Frame 4

## LEAN SUPPLY CHAIN MANAGEMENT

The online module for this field consists of an initial introduction to the

concept on Value Stream Mapping and Theory of Constraints (see Figure 5).

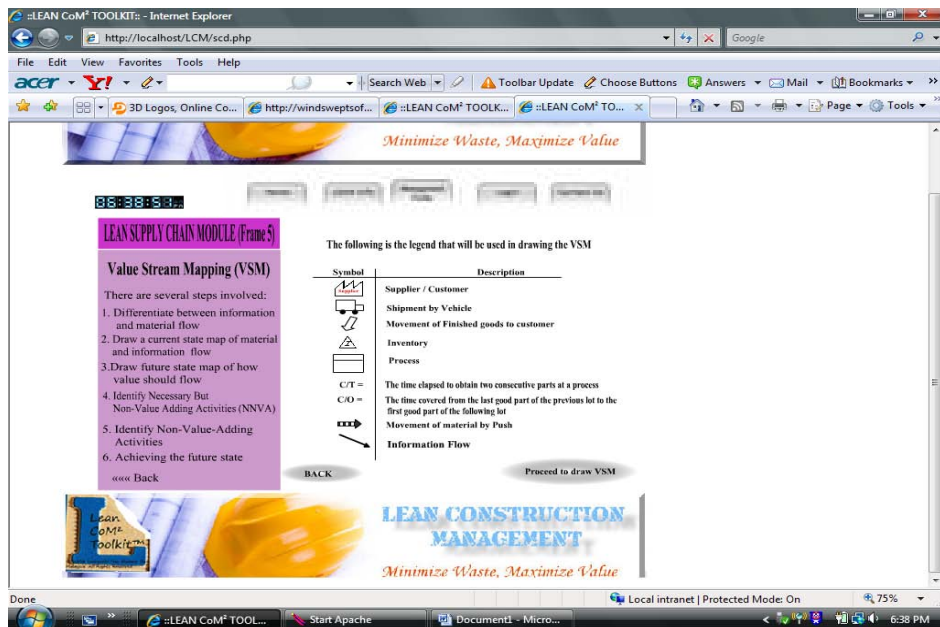


Figure 5: Lean Supply Chain Management Frame 5

The user is provided with the basic description of symbols that are in common use for the purpose of undertaking value stream mapping (VSM) and analysis (see Figure 5). A simple example is provided to enable the user to have a grasp of the VSM fundamentals - the critical steps of presenting the current state map and the future state map; and a brief

analysis is provided. The example (see Figure 6) provided essentially allows for calculating the Production Lead Time and the Processing Time so as to focus on reducing the lead time as a future state map. This VSM technique is applied to the key areas of: (i) information flow (ii) materials flow and (iii) equipment flow.

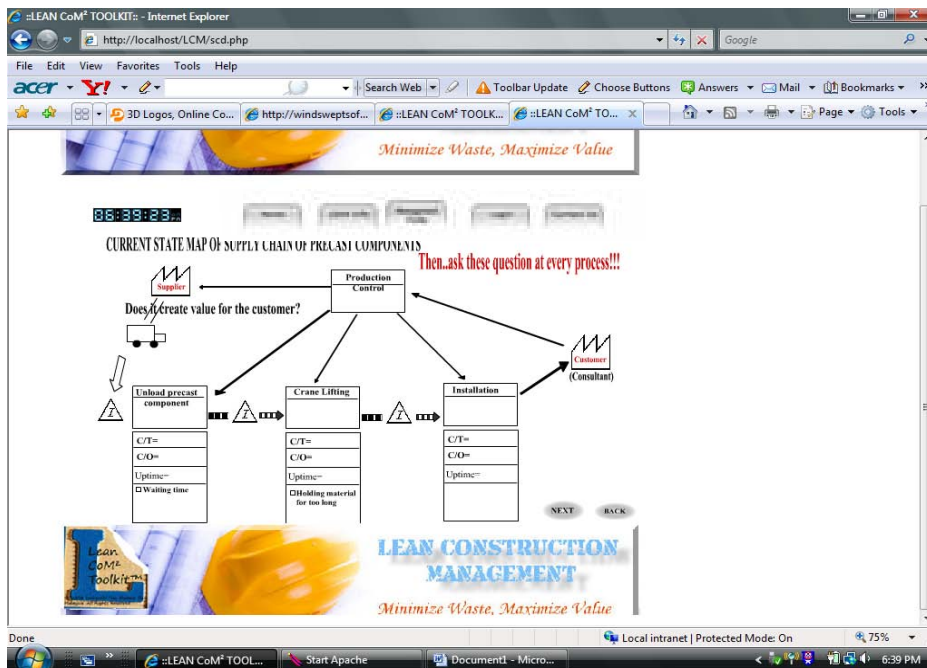


Figure 6 : Lean Supply Chain Management-Current State

The user is prompted to proceed to use the basic tutorial on performing an actual VSM analysis based on material flow and information flow programmed in Java. The PBL module and Action Learning Module fundamentally are based on the same concepts as in the case of Lean Design Management Field.

#### LEAN PRODUCTION MANAGEMENT

It is important to note that to enable the user to have a grasp of Lean Production Management, the focus on

production as flow is immediately emphasized as compared to the traditional notion of transformation. The two fundamental concepts emphasized are on the Last Planner System (LPS) and Look-ahead Planning-these are explained briefly. In the context of the requirements identified for this particular project implementation, these two concepts were seen as a necessary first step for any user not familiar with Lean Production.

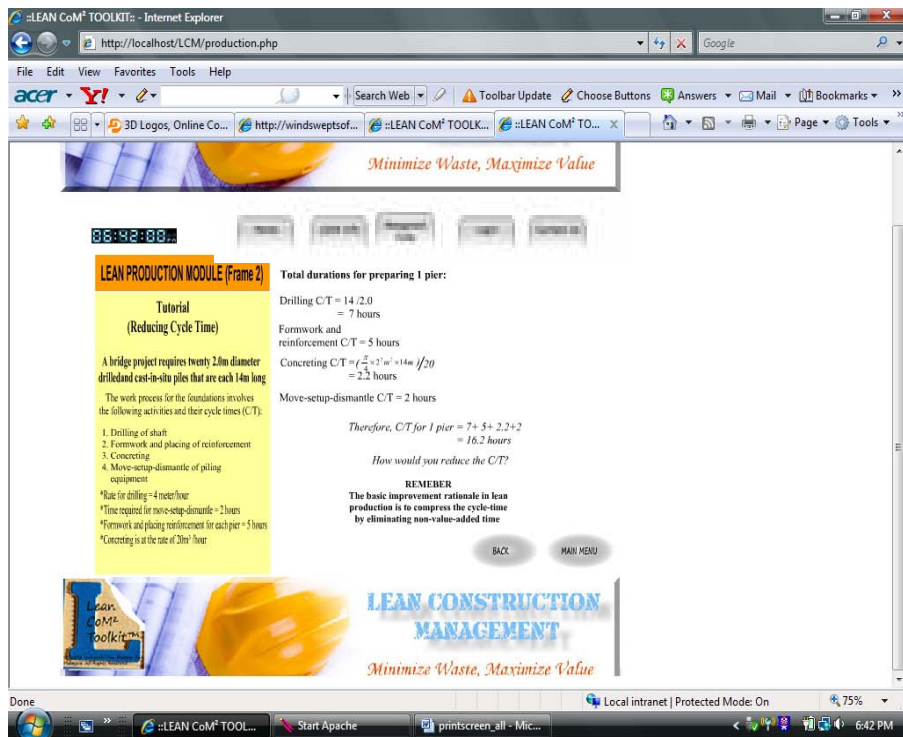


Figure 7: Lean Production Management

The online module consists of a simple case for foundation work as part of planning and scheduling of work based on traditional work breakdown structure (WBS) approach (see Figure 7 and 8). The user is prompted to review the calculations for the duration for doing foundation works involving drilling (involving move-setup-dismantle of equipment), formwork, reinforcement and concrete placement based on work structuring (WS) to make work flow more *reliably* and *quickly*. Thus, the user is prompted to proceed the planning and scheduling activities for the production based on "pull scheduling" that is enabled by using the Last Planner System. Hence, the lead time is reduced as the future state map is structured to indicate more

efficient production management based on reliable information and reduction of dependence on non-value added activities (this is the application of the theory of constraints technique, as well).

It is thus, emphasized that the notion of the last planner and having reliable commitments to achieve plan 100% complete is to be based on devising a six week lookahead plan. Additionally a weekly work plan and a daily work plan is to be structured on the same principle to the degree of high-level commitments from the last planner. The PBL module and Action Learning Module fundamentally are based on the same concepts as in the case of Lean Design Management Field.

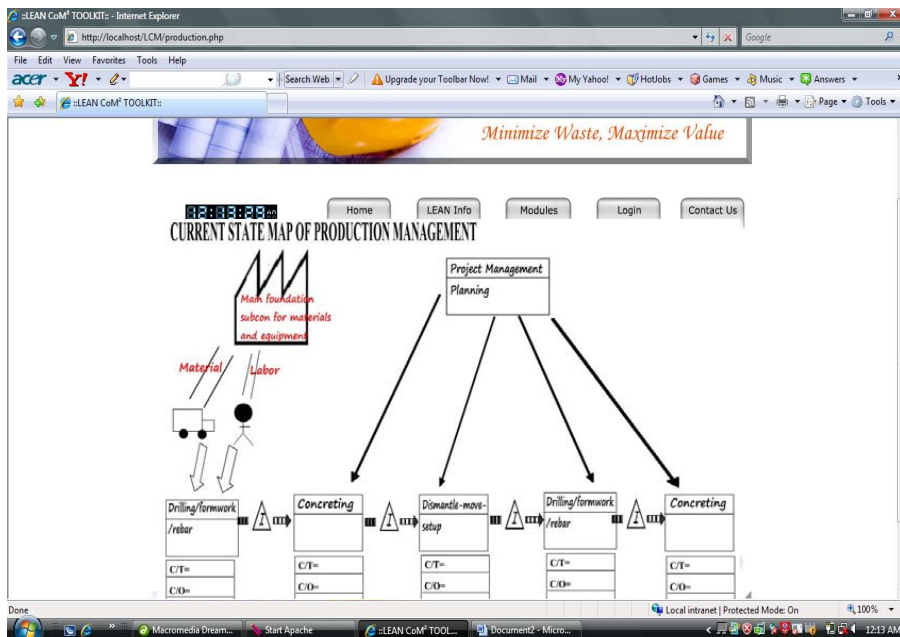


Figure 8: Lean Production Management – Current State

## CONCLUSION AND DISCUSSION

It is important to have in place a mechanism for introducing 'new' concepts, such as LCM, that takes into account the learning process as a situated practice (see Fox, 2004). This requires a more learner-centred approach that is contextualized as on the job learning, and is conceived as constituting a situated curriculum (Gerhadi, et. al., 1998). Learning can then be enhanced to take into account complex issues such as conceptual change, knowledge sharing and tacit knowledge. The LCM application scenarios are practitioner-owned-and-developed, that can be integrated into the project according to the feasibility or requirements of the specific project. Additionally, the Lean CoM² Toolkit has the potential to be utilized as a more systemic mechanism for learning on the job through a technology mediated focus (Jones et. al., 2006).

This provides an environment for conceptual change for undertaking LCM practice through a more consistent and highly focused Action Learning SET generation that is consistent with a flow view of the learning process (see Table 1). Thus, the problem of non-routine worker scheduling and constant sub-contract staff movement on projects that often hinders the full participation and commitment for implementation of 'new' concepts can be eliminated. The added value that this toolkit can provide is the incorporation of the system within the overall Web-based Decision Support System that is being designed based on Multi-agent system (MAS) concept for achieving 'real-time' construction project management that can further systemize the efforts for minimizing waste and maximizing value on construction projects.



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