METHOD OF INTERVENTION ON THE FLOW OF MATERIALS IN BUILDING PROCESSES

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Abstract

This paper discusses some aspects of a method of intervention in building processes that proved to be an effective mechanism for the learning of new production concepts. The intervention technique is designed to act as a starting point in quality and productivity improvement programs, which companies adopt and operate alone and in a competitive manner. It is oriented to producing rapid results, based on low-cost improvements, made without the need for changes in technology.

The method involves an intensive data collection, the group analysis and formulation of a plan of improvements related with the operations strategy. The entire process, including the application of the improvements and a second diagnosis, required around six months for the nineteen small and medium-sized building companies involved. The principal outcomes appear to be a motivation within the companies to continue the process of improvement which the intervention started coupled with changes in the site production culture.

Keywords: TQM, productivity, lean production, operations management, building process, process change, learning culture

1. INTRODUCTION

The application of the *new production philosophy* in construction is still scarce in comparison with other industries. The situation provides opportunities for early adopters to gain competitive advantage. Among the main concepts emerging are the reduction of the cycle time, increasing output flexibility, focusing control on the complete process, simplifying and reducing the number of steps/parts, building continuous improvement into the process, reducing variability, reducing the share of non value-adding activities, benchmarking, considering systematically the demands of clients and keeping transparency in the processes (Koskela, 1992).

The predominant conceptual model of construction as a set of conversion processes has contributed to the deterioration of overall flow efficiency. In contrast, in the contemporary production philosophy, the efficiency of production is determined by the efficiency of conversions (processes) *as well as* the flow activities (Shingo, 1988; Koskela, 1992).

The main objective of this research work was to devise a method of intervention in the flow of materials on building sites, based on the concepts of the new production philosophy. The flow of materials was chosen as a focus in the study because it is time consuming (Bishop, 1965; Forbes, 1971; Santos, 1995); it is the origin of a great part of safety and ergonomic problems (Niskanen & Lauttalammi, 1989); and it is one of the main causes of materials waste and unproductive labour time. As it is practically related to all activities on site, improvements in its efficiency are likely to have great impact on the project's global efficiency.

The method of intervention is also concerned with creating learning opportunities through the analysis and discussion of existing production practices contrasting with the approach of getting external solutions for dealing with isolated problems. The cycle of knowledge acquisition, dissemination and application within the company is improved by the method.

2. The Method of Intervention

2.1 Principles

In order to be applicable to the business environment and to the peculiarities of the building process, the method of intervention is based upon three core principles:

(a) short term benefits: in general, quality and productivity improvement programs create great expectations among company directors, managers, and workers. If such expectations are not fulfilled in the early stages of the program, a negative attitude towards the changes can result, and people may not get enough motivation for carrying out the necessary long terms improvements. Organisations can change in major ways if people have positive experiences with more modest, focused, and specific changes (Nevis, Dibella & Gould, 1995). The implementation of rapid and small scale improvements in the flow of materials can bring short term results, which can be easily noticed on site, and contribute to creating an improvement culture, leading to a major change in the company production philosophy.

(b) low cost improvements: the stage of development of the operations function role in construction companies is usually internally and externally neutral (reactive) to the needs of the company, using the Hayes and Wheelwright (1988) classification. This behaviour, associated with natural uncertainty, external and internal, may lead to the rejection of any kind of improvement that implies high investment.

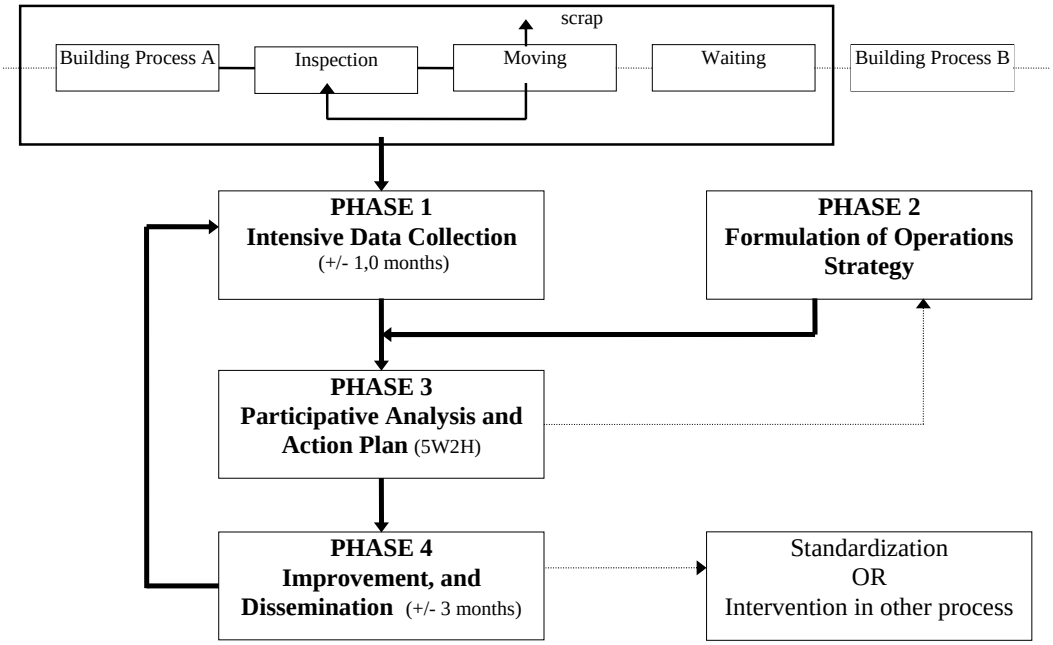
(c) without the need for significant technological changes: the method was devised to achieve the full potential of the current technology. Based on several previous studies, the authors have concluded that, there is generally a large, unused reserve of potential improvements in

building processes. An additional reason for rethinking the technological change is that the more invasive the change to an operation, the more disturbing this is for the organisation (Carr, 1994). Without a corresponding improvement in operations management, radical changes in technology often leads a deterioration in the flow activities (Koskela, 1992).

2.2 Description of the Method

The method is composed of four basic steps which follow the principles of the PDCA (Plan, Do, Check and Act) cycle. It also can be used in a *feedforward* fashion, in order to get information on a current technology before selecting and implanting a new one. The process exposed to intervention should be carefully chosen. It must be representative of a normal situation in the company and provide scope for the subsequent application of process and management improvements. In the 17 companies involved in the study, the method was applied to formwork, bricklaying, floor screed and plastering. Its first application involved the work of researchers in data collection, co-ordination of meetings, training and devising improvement plans. In the subsequent applications of the method, the companies carried out most of the work themselves, having the support of the research team through seminars and regular visits. The following figure describes the model of the method:

Figure 1 - Model of the Intervention in the Flow of Materials



The four main steps of the method are presented below:

(a) Phase one (data collection): the data collection techniques used in this phase are widely known and have been applied in several previous studies, such as work sampling, production charts, waste measurement, documentation of the process by normal and time lapse video and photos, productivity and quality indicators, flow charts, checklisting improvements, analysis of site logistics (Dunlap, 1970; Heineck, 1986; Skoyles & Skoyles, 1987; Kume, 1988; Juran, 1988 Meseguer, 1991). All the techniques are applied simultaneously in this phase during a period of approximately one month.

Most quality and productivity indicators employed in the diagnosis belong to a nation-wide set of indicators devised for monitoring the performance of the building industry (Oliveira et al., 1993), so that each company can be compared to the industry average performance and

benchmarks. The quality of operations management of each company is also evaluated in a qualitative way through a checklist containing a number of building process best practices, which were identified on a survey carried out in 45 Brazilian building companies (Formoso et al., 1994).

(b) Phase Two (formulation of the operations[1] strategy): the company needs to make explicit to the team of people involved in the intervention the strategic role of operations as well as a long term strategic improvement plan. Operations strategy is interpreted as the effective use of the operations strengths as a competitive tool for the achievement of business and corporate goals (Mills, Platts & Gregory, 1995). Whilst the operation strategy must be clear about the ends, it can be flexible about the means, focusing on one or two performance criteria.

The operations strategy has a key importance in focusing and linking the improvements carried out during the intervention with the strategic needs of the company. Also, by disseminating such higher goals, it is more likely to get group cohesion and team commitment (Scott & Townsend (1994).

(c) Phase Three (participative analysis, formulation of an action plan): after the data processing and the pre-analysis by the group responsible for data collection, a small group of people, representing different managerial levels (e.g. site manager, foreman, operatives), is formed. Their task is to analyse and discuss the information available, and propose an intervention plan, This analysis benefits from the participation of an independent external observer, with no knowledge about construction. It is essential that the analysis process is undertaken in an egalitarian manner with all participants equally respected in their contribution (Leonard-Barton, 1992). Before starting the discussion, it is important to make sure that all participants are aware of the company operations strategy. Without this, unnecessary improvements, or even counter-productive improvements may be selected.

The analysis is carried out in a brainstorming session and a 5W2H (What? When? Why? Who? Where? How? How much?)[2] plan should be produced in the end. It is important to highlight in the intervention plan a small number of key improvement actions in order to avoid dispersing efforts. The data, the analysis and the plan is disseminated throughout the company in seminars and training sessions.

(d) Phase Four (application of the improvements and dissemination): based on the work carried out in 17 companies, a period of three months seems to be enough for implementing the improvements, even when pilot studies are necessary. Long gaps between the diagnosis and the application of improvements should be avoided because the participants may lose the motivation and also the ability to remember important details about the process under intervention. The designation of leaders was found to be a success factor in applying and appraising the improvements in the case studies.

A *post-intervention diagnosis*, using the same techniques as the first one, is recommended in order to give feedback to participants on the results achieved and to refine the operations strategy. The traceability of change after the intervention can be done both in terms of status (e.g.: size of gangs, level of housekeeping), performance (e.g.: productivity, waste), and goals information (e.g.: reduction of absenteeism by 10%) (Cheng, Simmons, 1994). Based on the second diagnosis, the company may decide to establish standards or make a second

[1]Similar terms in the literature are production or manufacturing strategy. The term operations is used by Schroeder (1993) covering production and services activities. It cover all the equipment, methods, workforce, materials and environment involved directly in the production of the construction.

[2] Note that this differs from the traditional 5W1H by having the issue ‘how much?’.

improvement plan. Some of the companies involved in the study decided to extend the use of the method in other building processes.

3. Learning and Participation in the Intervention

The most competitive companies are characterised by the capacity to learn and change - consciously, continuously and quickly. The method of intervention is basically a process of learning from action, in a mode of active experimentation. Its success centres on the way it attempts to match the diagnosis and presentation to an individual user's preferred learning style. A multiple approach is used to treat the different learning styles[3] which co-exist in building companies. Adopting a multiple approach means using different types of information (e.g.: filming and statistics of work sampling), and operating at different levels of interaction, such as collecting data, testing improvements and the observation of other companies' practices.

Teamwork has had a key importance for the success of the method. According to Scott & Townsend (1994:62), working in teams is consistent with the values of today's employees, who are demanding more opportunity to influence decision making and to have meaningful work. The visible benefits of the improvements, plus the perceived participation and agreement with the goals, were shown to increase the efficacy of the process of intervention. By acting as a team, common problems of communication were reduced.

The use of benchmarking by quality and productivity indicators and best practices also proved to be an effective tool to improve the learning process. It provided an opportunity to challenge the narrow view held by some construction managers and workers, encouraging them to look beyond current traditions and to co-operate to adopt 'best available practices'.

In order to minimise the resistance to change, the improvements should be presented as a challenge giving a clear demonstration of potential benefits to all the participants. It is recommended to design the intervention so that it affirms existing values as much as possible without compromising the intervention. As with many previous studies, the results also confirmed that the support of top managers is vital for the success of the intervention (Carr, 1994).

4. The Operations Strategy

Several methods for formulating the operations strategy exists. In the present study, an adaptation of the model proposed by Slack (1994) was adopted. The model uses the *matrix importance x performance* in which a set of competitive factors are compared in terms of importance and performance, based on the managers' perception of the company's competitive environment.

The method proposed by Slack (1994) has the following steps, in order: presentation of the main operations strategy concepts to managers, identifying clearly the company product, identification of significant products/services, identification of a set of competitive factors, rating of priority for improvement, importance for customer's, performance relative to competitors and charting the results in the importance-performance matrix. The concept of qualifying criteria and order criteria of Hill (1992:10) was used in this process.

[3]In accordance with Powell & Newland (1992) the learning styles are divided into four different quadrants: dynamic, focused, rigorous and contemplative.

Eight basic categories of decision in the operation function were suggested to the participants: capacity, facilities, technology, vertical integration, workforce, quality, production planning and organisation (Anderson, Cleveland, Schroeder, 1989; Skinner, 1992). The participants added other areas in accordance with their needs and company structure.

5. Conclusion

Several conclusions could be drawn from that rich experience. Some of them are:

a) the simultaneous use of a bottom-up and middle-up-down approach for pushing the improvements reduces the problem of the frequent cornerstone in human resource management: the cross functional learning;

b) the biggest changes identified by the companies were in relation to the attitude of managers. It was verified that the intervention contributed to changing the role of that professional, by providing a structured source of ideas, thereby catalysing his ability as motivator and facilitator;

c) the images proved to be the most powerful instrument of communication. They created the contrast between current reality and the desired future, providing the impetus that moves the organisation forward to the learning organisation;

d) the evaluation of the effect of the intervention on the global productivity is very complex and it was not measured. However, at the level of the flow of materials the researchers found a posititive effects both in terms of quantitative and qualitative parameters;

e) the characteristics of educational experience, suggested by Argyris (1993), were all found in the cases studies. The method used real life problems, with actions connected to the participants' competence and skills and was focused on a non-routine problem about which the participants could take action. The lessons about leading-learning in intervention appear to be suitable for solving future problems (technical or human) similar or dissimilar to the one being used as the vehicle for learning;

f) the intervention can also be used as an audit process for a current strategy, assessing the existing practices in the diagnosis, analysing those practices against benchmarks, and making confrontation with the perception of the managers. The case studies showed a positive effect in the perception of problems with gaps and consistencies in the horizontal and vertical decisions of the company. Nevertheless, the same conclusion of Voss (1992:130) was found: the companies showed that to have a method is more important than the method itself.

The authors verified that the application of the method has repercussions in all activities interrelated with the process under intervention. Alternative methods of intervention in information flow or human resource motivation, for example, could be developed and added to the current method. The objectives of interventions focusing just on the human resource, for example, can vary from increasing competence to preparing changes in policy and rate from minimal invasiveness to highly invasive (Carr, 1994).

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