IMPROVING PERFORMANCE THROUGH MEASUREMENT: THE APPLICATION OF LEAN PRODUCTION AND ORGANISATIONAL LEARNING PRINCIPLES

Elvira Lantelme[1] and Carlos T. Formoso[2]

ABSTRACT

Performance measurement is an essential element of production management. It provides the necessary information for process control, and makes it possible to establish challenging and feasible goals. It is also necessary to support the implementation of business strategies.

Despite the fact that construction managers recognise the importance of performance measurement, it has not been widely implemented in this industry. Most managers still make decisions mostly based on their intuition and common sense, and on a few broad financial measures which are no longer adequate in today's competitive environment.

In the Lean Construction theoretical framework, performance measurement plays an important role in terms of providing process transparency. It makes visible attributes that are usually invisible, and helps the employees to see how they are performing, creating conditions for decentralised control to be implemented.

A number of studies have investigated the use of measures for evaluating the impact of improvement programs in production systems. However, few them are concerned with the problem of implementing measurement systems in organisations. Although choosing the right measures is important, it is also necessary to enable people to use measures in their routine work, so that root causes of problems are identified and corrective action implemented.

This article proposes a number of guidelines to implement performance measurement systems in construction firms, considering both the lean construction theoretical framework and organisational learning principles. This study is based on the development of a system of performance indicators developed for the construction industry in Brazil, and also on a number of interviews carried out with managers who have been involved in the implementation of measures in their companies.

KEYWORDS

Performance measurement, organisational learning, lean construction

---

[1]   MSc, PhD candidate at the Federal University of Rio Grande do Sul (UFRGS), Building Innovation Research Group (NORIE), Brazil,
e-mail: lantelme@cpgec.ufrgs.br.

[2]   PhD., Associate Professor at the Federal University of Rio Grande do Sul (UFRGS), Building Innovation Research Group (NORIE), Brazil, Visiting Scholar at the University of California at Berkeley, USA,
e-mail: formoso@vortex.ufrgs.br

INTRODUCTION

Several authors state that business performance can be enhanced by developing and implementing a balanced set of measures (Hall et al., 1991; Kaplan and Norton, 1992; Neely et al., 1996). Performance measurement plays an important role focusing people and resources on particular aspects of a business. Schieman and Lingle (1999), based on a survey with more than two hundred executives, concluded that measurement-managed companies exhibit better performance compared to their non measurement-managed counterparts.

Since the early eighties, the dissemination of the Total Quality Management (TQM) philosophy in Western countries has encouraged many companies to develop and implement performance measurement systems. In fact, some of the basic principles of TQM are strongly related to the use of measures, such as: provide feedback based on actual data, build continuous improvement into the process, and encourage the participation of employees in the decisions.

The application of the Toyota Production System (Lean Production) concepts and principles in several industries has also contributed for the widespread use of performance measurements. In the Toyota Production System, measurement systems are strongly related to decentralised control. Measures are intensively used in the learning process at the operational level, by helping the employees to see how they are performing, rather than simply to feedback data for the central control function.

However, the use of performance measurement is generally poorly explored in organisations. In many companies, managers tend to make their decisions mostly based on their intuition and common sense. Moreover, existing performance measurement systems are based on financial measures that have been strongly criticised for being out of step with recent changes in the industry related to the introduction of new technologies and to the growing competition (Kaplan and Norton, 1992). Among other problems, they tend to be backward focused, do not make it easy to trace operational costs, and fail to monitor the benefits of new investments (Berliner and Brimson, 1988).

The lack of performance measurement is a problem that also affects the construction industry. This is to a great extent related to the attitude and lack of training of managers. Generally, they are used to making their decisions based on intuition and experience, rather than on data collected through formal procedures. Moreover, devising a performance measurement system in the construction industry is a relatively difficult task for the following reasons:

(a) Construction is a project oriented industry: the product is usually unique in terms of design and site conditions, and a temporary organisation needs to be created for each project;

(b) Construction projects tend to be relatively complex: there is a wide variety of materials and components involved, many different agents take part in the process, and the final product has a large number of performance attributes.

The development of a performance measurement system usually starts with the selection of a set of measures. A number of papers that have been published emphasise the importance of selecting a balanced set of measures linked to the organisation strategic objectives. One of the most cited approaches is the *Balanced Scorecard* proposed by Kaplan and Norton (1996). Those authors proposed a model for developing performance measurement systems that includes both financial and non financial measures grouped according to four main headings: customer perspective, financial perspective, internal business perspective, and innovation and learning perspective. According to Waggoner et al. (1999) people tend to give more importance to the things that can be measured. This indicates that the selection of adequate measures has a major influence on the implementation of strategies and on the development of improvement programmes.

Although the importance of using sound selection criteria for the set of indicators must be recognised, this article is focused specifically on the difficulties faced by construction organisations in the implementation process. Such difficulties are concerned with the introduction of data collection, processing, and evaluation procedures, and the development of continuous feedback process that results in improvement and learning in organisations.

SCOPE OF THE STUDY

In Brazil, there has been a growing awareness of the importance of performance measurement in the construction industry. In the last fifteen years, due to higher competition and more demand for quality among customers, many companies have started to get involved in quality and productivity improvement programmes, usually based on the TQM philosophy.

In this context, a co-operation agreement was established in 1993 involving the Building Research Group (NORIE) of the Federal University of Rio Grande do Sul (UFRGS), the Association of Building Contractors of the State of Rio Grande do Sul (SINDUSCON/RS) and the Agency for the Support of Micro and Small Businesses (SEBRAE/RS). The aim of this agreement was to disseminate concepts, principles and practices for performance measurement in the construction industry, by devising a performance measurement system for the sector, named SISIND (System of Quality and Productivity Indicators for the Construction Industry). The SISIND Project has been focused on small sized construction firms, since they correspond to a very large percentage of the industry in Brazil both in terms of the number of companies and of output.

The following activities have been involved in the SISIND project: (a) devise a set of 28 performance indicators for the residential and commercial building segment of the industry, which can be used as a starting point for establishing sets of measures for specific companies; (b) produce a publication describing the set of indicators (Oliveira et al., 1995); (c) disseminate SISIND all over the country through presentations and training courses; (d) produce a yearly report based on the data collected by partner companies; and (d) develop research studies related to the definition and use of new measures for a number of key processes.

Since the launching of SISIND, several construction firms have joined the project and participated in training courses aimed at enabling managers to implement the proposed measures in their organisations. A database including data of approximately 80 companies and 200 projects has been created. In spite of the interest and motivation showed by the construction managers involved in the project, only a relatively small number of the companies have been able to apply performance measurement in a continuous basis. In most of them, managers have pointed out the lack of people and time to do the job as the main causes for not implementing measures (Lantelme, 1994). Based on these conclusions, a question was raised by the research team: if managers recognise the importance and benefits of measurement, why is it that they are unable to incorporate performance measurement in decision making?

This article proposes a set of guidelines for the implementation of performance measurement in construction firms. These are based on a literature review and also on a number of interviews conducted with managers who have been involved in the implementation of performance measurement: six from construction firms and three from other sectors (Table 1).

The literature review was focused on Lean Production and Learning Organisations. The aim was to understand the difficulties faced by managers during the introduction of performance measurement systems and to identify approaches that could support their implementation.

The aim of the interviews was to understand the main barriers to the implementation of measurement systems in construction companies and also to identify good practices in performance measurement both inside and outside this sector. The construction companies involved in the interviews typically had developed their performance measurement systems

recently, as part of TQM based improvement programs. Five of them had been involved in one way or another in the SISIND project, and four have recently obtained ISO9001 or ISO9002 certification. By contrast, all three companies from the other sectors could be considered measurement-managed organisations (Schieman and Lingle, 1999).

The interviews consisted of open questions concerned with the process of selecting measures, data collection and processing procedures, set of measures adopted, difficulties in terms of implementation, and impacts of the measurement system in the organisation (Lantelme, 1999).

Table 1 – Description of the companies involved in the interviews

COMPANY	MAIN ACTIVITIES	MAIS CHARACTERISTICS
A	Development and construction of residential buildings	Small company, all labour subcontracted. ISO 9002 certification Performance measurement system started in 1995. Initially 30 measures, currently 20
B	Steel production	Large company Performance measurement system started in 1989 as part of a TQM program. There are measures related to strategic targets (12 per business unit), and production units (maximum 5 per production unit)
C	Development and construction of residential buildings	Small company (60 employees, including construction workers) Performance measurement started in 1996 through the involvement of the company in a research project on waste prevention. Current focus on indicators related to the productivity of the crews
D	Development and construction of residential and commercial buildings, construction services for private clients	Small company, all labour subcontracted, ISO 9001 certification Performance measurement started in 1994 as part of a TQM program and also due to the participation in a training course. Most indicators currently being used are related to design review and to feasibility studies.
E	Development and construction of residential buildings, construction services for private and public clients	Small company Performance measurement system started in 1996, as part of a TQM program. The focus is currently on indicators related to human resources management (safety, turnover, etc.) and productivity of the crews
F	Construction of bridges, water services for public clients, and industrial buildings for private clients	Large company, ISO 9002 certification. Performance measurement started in 1997, through a joint development study carried out by a group of companies, with the support of a research team..
G	Development and construction of residential buildings, construction of industrial buildings, production of pre-cast building components	Medium size company. All labour subcontracted. ISO 9002 certification. Performance measurement started in 1995 due the involvement of the company in a training course. Used SISIND set of indicators for 2 years. Currently the set is being revised.
H	Production and transmission of electricity	Medium size (300 employees) Performance measurement was initially introduced due to demand from the state government. Later a measurement system related to the process of strategic planning was developed. Data collection and processing is mostly automated.
I	Production of components for car assembling companies	Large multinational company. Performance measurement is divided in three levels: (a) strategic (16 measures); tactical (19 measures); and operational. Measures related to strategic planning started 6 years ago.

ORGANISATIONAL LEARNING

Organisational Learning is an area of knowledge concerned with how to make organisations competent on adapting itself to the constantly changing business environmental demands. This means not only that people in the organisation must learn new concepts and technologies, but also develop learning to learn capabilities. Many organisations face great difficulties to learn how to learn and prefer to hire third party consultants to help them when they need to make changes, instead of using their internal knowledge capabilities. (Sweringa and Wirdsma, 1995)

Tsang (1997) analysed the learning organisation approaches presented by many authors and concluded that learning organisational concepts are related to both cognitive and behavioural changes within organisations. Learning is normally related to individual or organisational performance improvement. The same author also found that these studies present two distinct perspectives. The first one, which he called prescriptive, states that learning is a natural process in organisations, which means that all organisations have developed some learning capabilities, although they may result in unconscious and informal learning processes. The studies that emphasise this perspective try to understand how organisations learn.

The second perspective, called descriptive, assumes that learning happens only under certain conditions, which implies that organisational learning must be a formal strategy consciously adopted by organisations. Both perspectives contribute to the identification of some general principles and approaches for the development of new organisational competencies. Some of them are summarised bellow.

Learning is a process that happens in cycles. Sweringa and Wirdsman (1995) identified three learning cycles in organisations. The first cycle develops when the rules and routine procedures are questioned and modified, due to undesirable results. The second cycle develops when simply changing rules is not sufficient to improve performance. This can lead to questioning the insights and knowledge used for developing the rules. The third learning cycle develops when the organisation questions its own strategies and principles.

Argyris and Schon's theory on congruence and learning also propose that learning develops in single or double loops (Anderson, 1997). According to that theory every human action results in intended or unintended consequences. When the consequences are unintended, it implies that changes are necessary and these changes can happen in two different ways: (a) simply changing the action; and (b) questioning the theories, knowledge, behaviours and other variables that lead to action. The authors called these single and double learning loop respectively.

Kolb (1996) proposes that effective learning happen in a circle where experimentation, reflection, conceptualisation and decision are inseparable and continuous parts. In his model the author calls attention for learning as a conscious formal process that goes from concrete to abstract and from action to reflection. It means that learning is a cyclic process where the results of actions should be evaluated and next actions should be taken based on reflections about them.

Many approaches to Organisational Learning are related to problem based learning processes, from which new actions emerge based on a cyclic and continuous process of reflection. In this article, organisational learning is understood as a collective formal process that results on new actions or behaviours and increases the capability of the organisation to make its own future changes.

Authors like Senge (1990), DiBella and Nevis (1998), Garvin (1993) and Pedler et al. (1991) discuss approaches and practices that facilitate learning. They believe that there are two main barriers to learning in organisations. One result from the way in which individuals have been trained to think and act, and the other from the fact that organisations are not used to discovering and using their own solutions for problem solving.

Garvin (1993) suggests that learning occurs when organisations are competent on systematic problem solving, experimentation with new approaches, learning from their own experience and past history, learning from the experiences and best practices from others, and transferring knowledge quickly and efficiently throughout the organisation.

Pedler et al. (1991) presented several characteristics of a Learning Organisation. Among them they highlighted the use of information to improve dialogue and questioning in an interesting, challenging and open way; the development of the company's strategy and politics through a participatory process; the development of flexible organisational structures, rules and procedures; the creation of a learning climate, where people can learn from their own mistakes and where experimentation and continuous improvement is encouraged.

According to Senge (1990), what distinguishes a Learning Organisation is its mastery or focus on five disciplines. The main one is systems thinking, which integrates the other four: mental models, personal mastery, shared vision and team learning. For Senge (1999) organisations need to develop reflection and inquiry skills as well as system thinking skills, which means developing abilities to see the dynamic complexity of systems and to move beyond blame to find the real causes of problems and areas of leverage, avoiding the common symptomatic solutions.

DiBella and Nevis (1996) discussed some conditions or practices that facilitate learning, which include: seeking information about the external environment, concern for measurement, climate of openness, continuous education, personal and active involvement of leadership in learning initiatives, system perspective, valorisation of different methods, procedures and competencies and others.

The Organisational Learning concepts and ideas presented above can help to better understand the barriers faced by managers when implementing performance measurement as well as other improvement programs. In this respect, special attention must be given to the way evaluation and decisions are made in process management. Both operational and behavioural changes need to be made in order to introduce such changes.

Conversely, performance measurement can also contribute to the learning process within organisations. When it comes to the implementation Lean Construction concepts and principles, for instance, it is important to create conditions for learning by allowing managers to evaluate the impact of improvements in the production system, so that they can question their own knowledge and mental models. The implementation of performance measurement systems can support the learning process as well as enable managers to clearly understand the changes that take place during process improvement.

PERFORMANCE MEASUREMENT IMPLEMENTATION PROBLEMS IN CONSTRUCTION COMPANIES

Both the development of SISIND (Lantelme, 1994) and the interviews (Lantelme, 1999) indicated that the and implementation of performance measurement systems has both organisational and behavioural barriers. From one hand, most small sized construction firms lack a minimal organisation for data collection and processing. On the other hand, when it comes to decision making and problem solving managers tend to rely more on their intuitive and experiential knowledge rather than on a structured set of tools and data that can help understanding the problem.

Also, some of the interviews indicated that construction managers tend to look for short time results. As performance measurement is not simply a matter of collecting data, it is necessary to make an effort in terms of processing data, evaluating and disseminating information, and involving people in decision making. The consolidation of such routine procedures in an organisation takes time, and the benefits of measurement usually cannot be perceived in the short

term. As a consequence, some managers loose motivation for the implementation of performance measurement after a while, since they have other priorities in mind, such as meeting time deadlines and cost goals. In this situation, they perceive the costs of measurement higher than the benefits obtained, and the implementation process is often interrupted. That was the case of several construction firms involved in the SISIND project (Lantelme, 1999).

In some construction companies, it was observed that managers, when analysing the company performance measurement results, tend to look mainly for who or what is to blame for the existing problems. Instead they should be thinking systemically about the process that generated the results and what could have been done to improve them.

The fact that systemic thinking is not common in the companies may also lead to a lack of confidence from the managers on what is being measured and whether the measures can represent satisfactorily the process or results they refer to. For example, Company D had been measuring the economy of the reinforced concrete structure design using two indicators: the relation between the weight of steel bars and the gross floor area, and the relation between the volume of concrete and the gross floor area. The results from one structural designer in a specific building for both indicators were considerably worse than the reference values available. This higher expenditure of concrete and steel existed because a transition beam had been designed in order to create the necessary parking space in the basement. The manager justified this result by arguing that the reference values were not adequate in such case, since that was a different kind of reinforced concrete structure. What this manager had not seen was that the efficiency of the structural design could be improved (and of the indicators as well) by changing the architectural design, by introducing modular co-ordination, or even by developing a more integrated design process.

This kind of attitude also results from a centralised view on control. Managers tend to think about measurement only as a tool for controlling people's behaviour. Instead they should see them as a way of communicating goals, sharing responsibilities and learning in organisations. One manager, for instance, stated that productivity measures were mostly used to control employee's performance and to dismiss the ones who could not achieve established performance goals (Company C).

Both the development of SISIND (Lantelme, 1994) and the interviews made with construction managers offer indications that much needs to be done to spread out the development of performance measurement systems in the construction industry in Brazil. Among the companies involved in the study, even those that have initially developed an adequate set of measures have found difficulty introducing them systematically in process control. Some of them lacked people with experience and knowledge on collecting and evaluating data. That is why the introduction of performance measurement systems is not simply a matter of selecting the right measures, but it also implies in a much deeper change on the way decisions are made.

Despite all difficulties faced by managers, it was observed that the measures adopted by the construction companies involved in the study have improved process transparency, and generated good opportunities for reflection and questioning about process results.

GOOD PRACTICES IN PERFORMANCE MEASUREMENT

The use of performance measures is strongly related to the necessity of improving process transparency in production management. By using indicators, some of the invisible attributes of the process are made visible (Koskela, 1992). However, a high level of transparency in a production system is only achieved when measures are made available using an adequate visual presentation for everyone in the company. This practice was found in the three measurement-managed companies (B, H, and I).

In all of these companies, strategic planning played a very important role in the development of the measurement system. Each set of measures was divided in hierarchical levels, in order that there was a clear link between the higher level measures, which were related to the company strategic objectives and goals, and the measures at the operational level – this practice was not observed in any of the construction companies involved in the study. Periodically the set of measures is evaluated and updated, if necessary, at each hierarchical level.

Also, in the measurement-managed companies there were evidences that measures were thoroughly incorporated in the decision making process, and often linked to the company's rewarding system. Indeed, the implementation of performance measurement was strongly related to decentralised control. Measures helped the employees to see how they were performing, and also enabled them to make decisions at the operational level.

Another good practice found among the three companies from other sectors was simplification. In the context of performance measurement, simplification means easy to access data and easy to understand measures. Complexity is not desirable in any situation as it increases costs and reduces reliability. Measurement itself is a costly activity as it spends time and resources from the organisation. Besides it can bring substantial changes in people's routines. Therefore, when selecting performance indicators or planning for data collection it is worth thinking about the criteria used, the procedures that need to be developed or changed in order to introduce this activity as well as the necessary training of people.

The interviews with managers of Companies B, H, and I also indicated that reducing measurement cycle time is important to increase reliability, motivation, as well as the potential for improvement. It was observed that the period of time between data collection and dissemination of the results to support decision making should be as short as possible. This principle contrasts with the practice adopted by one of the construction companies (G), in which all data were sent to a specific sector of the company which was responsible for processing and analysing the results periodically. That procedure was not successful, firstly because people from production did not hand the data over at the right time, and, secondly, when enough data was gathered to perform an analysis these could no longer be used for real time control.

One strategy for expediting the process of data collection, processing and dissemination is to automate it as much as possible. This was observed in all measurement-managed companies, specially in Company H. They all have developed computerised systems that allow data to be inserted as near in time and space as possible to the place where it is gathered. As such systems are accessible by an internal web, data can be automatically processed and represented using visual formats that make them easy to access by anyone in the organisation.

Finally, another good practice that was observed in measurement-managed companies was benchmarking against the industry best practices. It was recognised as an important strategy to support continuous improvement in the organisation. In fact, the manager of a construction firm (Company A) mentioned that, after five years of implementation of the performance measurement system, some people in the organisation lost interest on the measures. According to him, this has happened because most of the measures reached a relatively stable level, which meant that the processes were under control. In that case, a benchmarking process could change the situation by giving new challenges and goals for process improvement.

GUIDELINES TO THE IMPLEMENTATION OF PERFORMANCE MEASUREMENT

The following guidelines aim at creating the necessary conditions for implementing performance measurement in construction companies. They can be used either on the development or on the analysis of existing measurement systems:

(a) Transparency: performance measurement is an essential component of the principle of improving process transparency, but its effectiveness also depend on whether other components of process transparency exist. It means that information must be shared, communicated and presented in an easy to understand format, and a more autonomous, participatory decision-making process should be established.

(b) Moments for reflection: formal moments defined at specific work times should be established in order to property evaluate the results and develop new plans. These meetings should be held in an open and participatory climate, in which questioning, reflection and creativity can flourish.

(c) System thinking: this way of thinking should always be practised, so that the variables that influence the results are properly understood. Often the causes of problems are separated in terms of space and time, and only by understanding the system complexity and dynamics can organisations find leverage areas. Spending time and efforts on looking for blame and justifications will not help changing bad results.

(d) Reducing cycle time: processing time should be reduced in order to provide on time information for improvement. In this specific matter, automated data collection and processing, and the use of internal computer networks can play an important role.

(e) Simplification: this means, from one hand, reducing the number of measures used, and on the other hand, using control systems and procedures that already exist in the firm. In addition, each measure should be analysed in a critic way and, if necessary, be modified in order to make it easy to understand for everyone in the company. Simplification results in cost reduction and increased reliability.

(f) Benchmarking: the continuous improvement of measurement systems depends on the linkage to the company's strategic objectives as well as the establishment of challenging goals. Benchmarking allows managers to constantly revise processes and compare the existing performance to competitors'.

FINAL COMMENTS

The application of Lean Production concepts and principles to construction demands a change in production management, in which performance measurement plays an important role. Measures are important in terms of providing process transparency and the necessary information for continuous improvement.

The implementation of performance measurement systems requires the selection of an adequate set of measures, but it is also necessary to create conditions that enable them to be incorporated in decision making, at different levels of the organisation. These conditions are concerned with procedures, rules, routines as well as abilities and attitudes. This implies changing the way management is conducted within the organisation, by creating a more transparent and participating environment.

This article discusses some of the existing barriers for the implementation of performance measurement in construction companies. It also presents some good practices identified in companies from other industrial sectors. Based on that and also on a discussion of concepts and principles from the field of organisational learning, some general guidelines for the implementation of performance measurement systems are proposed. Considering the problems faced by the construction companies, much further research work is needed on this theme.

REFERENCES

Anderson, L. (1997). **Argyris and Schon's theory on congruence and learning**. [on line]. Available at http://www.scu.edu.au/schools/sawd/arr/argyris.html.

Berliner, C. and Brimson, J.A. (1988) **Cost management for today's advanced manufacturing**: the CAM-I conceptual design. Boston, Harvard Business School Press.

DiBella, A.J. and Nevis, E.C. (1998) **How organizations learn**: an integrated strategy for building learning capability. San Franciso: Jossey- Bass. 216 p.

Garvin, D.A. (1993) Building a learning organization. **Harvard Business Review**. July- August. p. 78-91.

Kaplan, R.S. and Norton, D.P. (1992) The balanced scorecard – measures that drive performance. Boston, **Harvard Business Review,** Jan.-Feb. 1992: pp.71-79

Kolb, D.A. Management and the learning process. In: STARKEY, Ken (ed.). **How organisations learn**. Thompson Business, 1996.

Koskela, L. (1992) **Application of the new production philosophy to the construction industry**. Stanford, CIFE. Technical Report #72

Lantelme, E. (1994) **Proposal for a quality and productivity indicator system for the construction industry.** Porto Alegre, Brazil, Federal University of Rio Grande do Sul. M.Eng. Dissertation (in Portuguese)

Lantelme, E. (1999) **Use of indicators in process evaluation and performance improvement in the construction industry**: an approach based on the principles of organisational learning. Porto Alegre, Brazil, UFRGS. Doctorate Seminar Report (in Portuguese)

Oliveira, M.; Lantelme, E. and Formoso, C.T. (1995) **System of quality and productivity indicator for the construction industry:** user manual. Porto Alegre, Brazil, SEBRAE/RS. (in Portuguese)

Pedler, M.; Burgoyne, J. and Boydell, T. (1991) **The learning company**: a strategy for sustainable development. London: McGraw-Hill. 213 p.

Senge, P. (1990) **The fifth discipline : the art and practice of the learning organization**. New York, Doubleday.

Schiemann, W. A. and Lingle, J.H. (1999) J. H. **Bullseye! – hitting your strategic targets through high-impact measurement**. New York: The Free Press. 206 p.

Sink, D.S. and Tuttle, T.C. (1993) **Planning and measuring for performance**. Rio de Janeiro, Quality Mark. (in Portuguese)

Sweringa, J. and Wierdsma, A. (1995). **La organización que aprende** (The learning organisation). Delaware: Addison-Wesley, 1995. (in Spanish)

Waggoner, D.B.; Neely, A.D. and Kennerley, M.P. (1999) The forces that shape organisational performance measurement systems: an interdisciplinary review. Elsevier, **International Journal of Production Economics**, 60-61: pp.53-60.