FACTORY MANAGEMENT AS A COMPETITIVENESS FACTOR. STUDY OF INDUSTRIAL BENCHMARKING IN THE CERAMIC CLUSTER.

Corma P. [1] and Carda J. B. [2]

[1] QPT, S.L., [2] QIO Department of Universidad Jaume I of Castellón. Spain

ABSTRACT

The main objective of this study has been to survey the present situation in ceramic floor and wall tile companies from the point of view of industrial facilities management, establishing the strong points and areas for improvement, while simultaneously proposing alternatives for improving their competitiveness.

In the companies of the ceramic cluster (floor tile, glaze and frit, machinery, additives sectors, etc.) it is quite usual to perform comparative studies in relation to international markets, product ranges, published economic results, etc. Thus, 'Benchmarking' is used in the ceramic cluster, whether consciously or not, as a method for evaluating own data with regard to that of the competition, and for identifying best practices that enable improving own practices.

However, in regard to industrial facilities and production process management, it has been custom to make superficial comparisons based on horizontal information transfer (suppliers, companies' own professionals, etc.) rather than do this in a structured form, taking common elements or agreed bases of comparison. This leads all too frequently to comparisons with little objectivity or to error, as a result of not using common bases of comparison.

In order to complete the information on the ceramic cluster and also to be able apply benchmarking in regard to installations and production processes, this paper presents a method based on Kobayashi's 20 keys model. An industrial diagnosis of 31 companies from the ceramic cluster has been made (taken from the ceramic tile sectors and having differently sized installations) using a model based on Kobayashi's 20 keys, fully adapted to the ceramic companies:

- *Adapted questionnaire*
- *Adapted improvement processes*
- *Adapted scoring system*

The work has been carried out in two periods: a first period in 2002 and the beginning of 2003, and another at the end of 2004 and beginning of 2005. In absolute terms, this was the period of maximum productive capacity, while improvements and reforms were also undertaken in the facilities. Having data on the same installations during two periods of time enables verifying, simultaneously, the evolution of some of the analysed criteria and analysing the influence that the slowdown in production in these years has had on these.

The results obtained are presented in groups and in different breakdowns (type of company, size), while also proposing this approach, once the results had been validated, as a model for analysing the industrial situation of the companies and for benchmarking with well-defined, common bases. The paper sets out quantitative data on the comparison, distribution of the deviations, elements for improvement, etc. The work is, furthermore, an X-ray of the state of the industry and management of the production processes in the Spanish ceramic cluster.

1. THEORETICAL FRAMEWORK

The Technique which we shall term '20 keys for industrial improvement' (specifically adapted to the sector from the same technique developed by Iwao Kobayashi) involves a system that defines excellence in 20 areas that have an important influence on:

- Cost
- Quality
- Delivery time

At the same time, it interrelates all the areas, so that joint and coordinated work directly improves the competitiveness of the company from an industrial standpoint.

In the last 20, 15, 10, 5 years, we have witnessed continuous changes in the world of manufacturing, such that the stability and even the competitive permanence of companies depends on:

- Improvements in productivity
- Quality of manufacturing
- Quality of industrial process management

The changes in economic cycle directly affect ceramic tile demand, while new, competing manufacturers also enter the market, in addition to new alternative products, etc. It seems reasonable to think that only the companies that have systematically improved their methods of work will have competitive advantages in the short and medium term. The first step on this way of improvement is self-assessment, in order to establish the situation with regard to predefined, commonly accepted standards, as well as by comparison with competitors.

Self-assessment must be completed by comparison with other companies, since the prospect of only complying with standards is insufficient, since it tends to be satisfied with compliance with an existing state, without taking into account possible advances of the competition. There is a tendency to stagnation. On the other hand, not only the participation in the market, prices, etc. must be compared with those of the competition,

since that means just analysing the effect, and not the causes. It is necessary to compare productivity, quality, costs and other important market aspects, because all these features together will determine the relative position of the company in the future.

Thus, the above, leads to the need to establish criteria for evaluating and comparing production quality.

2. CRITERIA FOR EVALUATING AND COMPARING COMPANIES INDUSTRIALLY

The recent history of the ceramic companies has demonstrated that remaining profitable, and even overcoming difficult spells, are directly related to the skill and rapidity in adapting processes, including the technology, to market demands. Questions such as the following then arise:

- How to evaluate the capacity to adapt?
- What to do after the evaluation?
- What path is to be travelled if the capacity to adapt is comparatively low?
- Is the adaptation proportional to the investment capacity?
- How do people take part in the adaptation process?
- Etc.

In order to evaluate and compare production quality it is necessary to have a method that meets a series of requirements:

- Clear system of the elements to be evaluated. List of elements.
- Defined scoring system. Scaled as a function of reached achievements.
- Accepted system. Single and clear score criterion.
- System of steps or achievements to be made, to pass from one level to the next.

Viewed in the foregoing form, the evaluation system set out in the present study meets the three basic requirements:

- It serves to evaluate, in absolute values, the situation of the company with regard to a reference system.
- It assumes a reference system to determine the path to be travelled to obtain the maximum score.
- It serves to compare itself, since it involves the same scoring system on predefined situations and attained achievements.

With the above, a system of evaluation (or self-assessment or, even better, independent external evaluation) is obtained, similar to that which the EFQM proposes for its different evaluation systems.

In order to achieve this, after Kobayashi, we propose:

- 20 criteria that define comprehensive excellence in production
- System of 5 score levels

The 20 criteria:

- Cleanness and Organisation
- System rationalisation by target management
- Improvement groups
- Stock reduction
- Rapid change technology
- Value analysis in production
- Manufacture with minimum control
- Connected production process
- Equipment maintenance
- Policy of work times
- Quality assurance system
- Supplier management
- Waste elimination
- Preparing people to perform improvements
- Multi-skilled workers
- Production programming
- Efficiency control
- Use of new technologies, computers and microprocessors
- Saving and conservation of energy and materials
- Technological capacity

The 5 score levels:

- Level 1: Initial state, without appreciable results, without raising awareness regarding the criterion
- Level 5: Ideal final state, maximum efficiency.

The connecting elements are always:

- Better quality
- Lower cost
- More rapidly
- Safer

For this, it is necessary to improve the 20 criteria, in a coordinated fashion, following the scheme proposed by Kobayashi (Figure 1).

The Diagram features four external factors:

- Cleanness and Organisation: nº 1
- Target management: nº 2
- Improvement groups: nº 3
- Technological capacity: nº 20

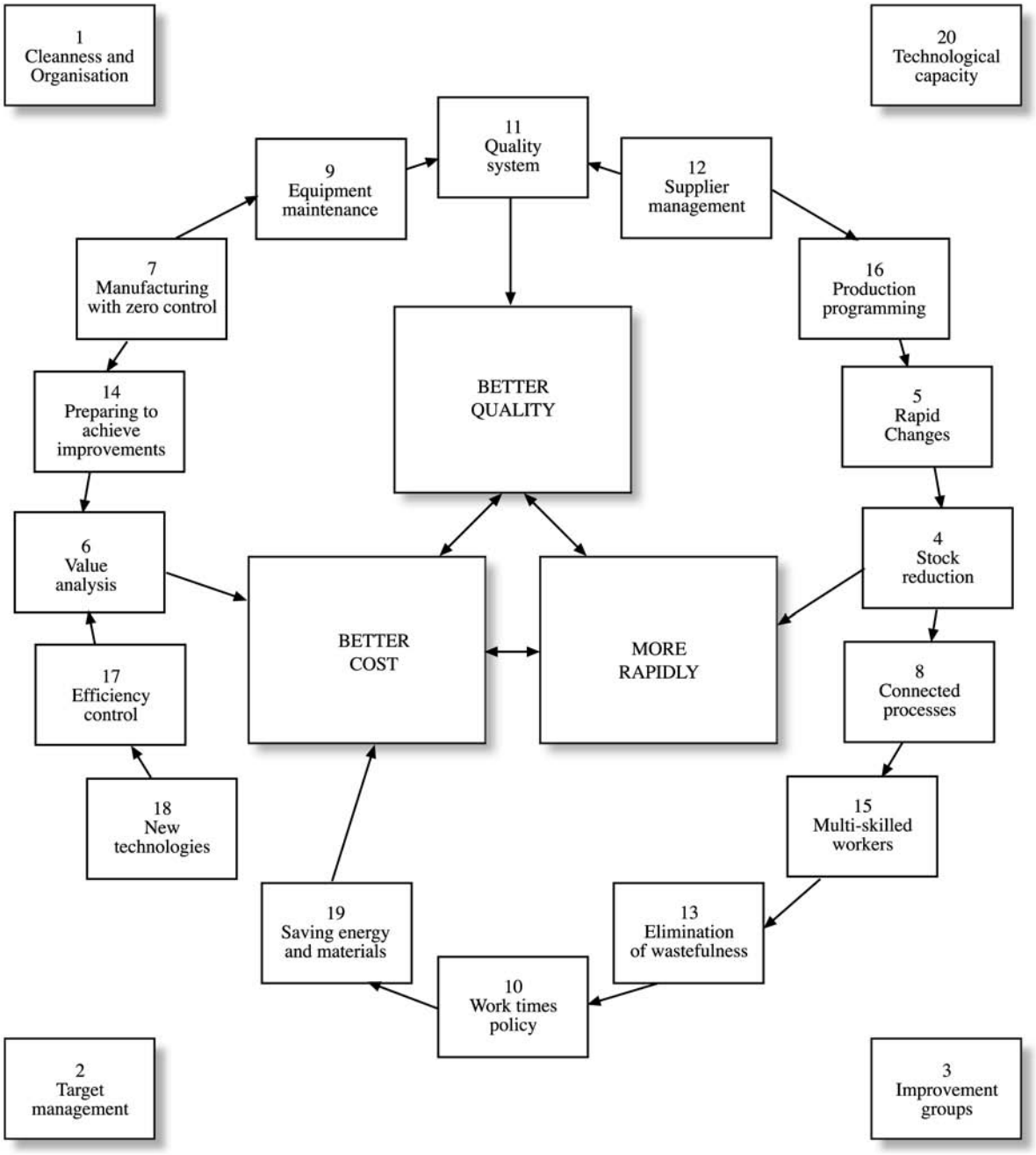

Figure 1. Diagram of the interrelations of the 20 criteria for excellence in production

- These four factors support the other 16 factors, which are internal.
- There are three criteria with a direct relation to the determining elements of manufacturing quality:
  - Stock reduction (nº 4): Direct relation with 'more rapidly'
  - Value analysis (nº 6): Direct relation with 'lower cost'
  - Quality system (nº 11): Direct relation with 'greater quality'
- Interconnections:

- The connected processes (nº 8) and the rapid changes (nº 5) help reduce stocks (nº 4)
- Supplier management (nº 12) and good programming (nº 16) will help the rapid changes (nº 5)
- To achieve stable production with minimum supervision (nº 7), good equipment maintenance (nº 9) and workers who are prepared to make improvements (nº 14) will be required
- To obtain results in value analysis (nº 6) it will be necessary to perform an efficiency control (nº 17), while also preparing the workers to achieve improvements (nº 14)
- The policies of work times (nº 10) will be a consequence, among other things, of the elimination of wastefulness (nº 13) and, with this, we will be able to save energy and materials (nº 19)
- Etc.

The mode of operation or methodology for applying the Method of the 20 criteria for manufacturing improvement is consistent with the PDCA system: Plan, Do, Check, Act, Plan....

Finally, the Method involves, necessarily, the development of Improvement Groups, Work Groups, in short: teamwork. This means:

- Decided support by Management
- Resources for development
- Preliminary Training and Motivation to enable these Teams to emerge in the Organisation

3. SURVEY DETAILS

- 31 ceramic tile companies:
  - 16 with no more than 2 production kilns
  - 10 with 3, 4 or 5 kilns
  - 5 with more than 5 kilns
- conducted in two periods: 2002-2003 and 2004-2005.
- All the companies are located in districts of Castellón.
- Conducted by fieldwork at the companies' own installations.

4. RESULTS AND DISCUSSION

Key 1 (Organisation, Order and Cleanness) is presented in detail (Table 1), showing how it is interpreted. Subsequently, examples of the adapted Tables are presented, for making the industrial evaluation (Tables 2 to 6). In each table the initial situation (element to be identified) is indicated with the corresponding score. This leads, automatically, to the action or actions for improvement to be undertaken to achieve higher scores; i.e. for solving the detected problems.

(1) level	(2) SITUATION	(3) tick	(4) ACTIONS PROGRAMMED TO GO TO NEXT LEVEL	(5) Resp.	(6) Date	(7) Indic
1	General dirt		Observe all the surfaces, both horizontal and vertical, and check the dirt and disordered or unnecessary items. Perform a detailed inventory			
	Cigarette butts, papers and rags on the floor					
	Scattered tools					
	Spilt glaze		Eliminate all the refuse and mal-functioning or unnecessary tools. Store the tools. Put nothing on the floor. Every thing in its place. A place for every thing			
	Disordered screens					
	Dust everywhere					
2	There are no clear routes		Observe the walls, pillars and corners:			
	The passage sites are not indicated		Eliminate refuse and non-essential tools			
	Disorder on walls, pillars and in corners		Store tools			
	Rubbish in corners		Assign responsibilities per areas			
	Unused tools next to machines		Inform each person of his/her responsibility in his/her area			
3	Cleanness and clear routes but tool disorder in the store		Classify the tools and spare parts by shelves			
			Eliminate closed cabinets and closed drawers			
			Identify everything to see it clearly			
	Mixed tools. Mixed spare parts		Leave the most frequently used tools ordered and within reach			
			Always put the tools back in their place			
4	Cleanness, clear routes and order but excessive number of tools and instruments, parallel and at right angle		Develop visual control of the stock, by colours, locations, etc.			
			Direct drop of waste in containers			
			Create a supermarket-type pilot line of tool order and with visual control			
5	Constant and planned cleanness, with assigned responsibilities. Clean and ordered work area. Ordered and identified tools		Remarks:			

(8) (9)

(1) Possible levels or situations
(2) Description of the situation
(3) Tick the observed feature
(4) Actions to be performed to improve and change level
(5) Person in charge of manageng the improvement
(6) Date foreseen for results
(7) Indicator associated for monitoring
(8) Maximun level attainable
(9) Possible commentaries regarding the Criterion

Table 1. Key 1 of Organisation, Order and Cleanness. Description of contents and interpretation

4.1. EXAMPLES OF TABLES USED

4.1.1. Criterion 2: Target Management

To achieve the general goals of the company, the individual ones of each Section must be met, which is why it is necessary to define targets for each place of work, and for each Section, and to do this in a participatory way, so that the resulting plans will enjoy the support of the organisation

level	SITUATION	tick	ACTIONS PROGRAMMED TO GO TO NEXT LEVEL	Resp.	Date	Indic
1	Gang style. Without defined Targets and obeying only the instructions of the immediate superior		Define the Organisational chart and specific functions			
			Define responsibilities			
			Describe the workplaces			
2	An organisational chart but the Management guidelines are not known		Quantification of Targets at all the levels			
			Inform of Policy and Strategy			
	Lack information of Management		Know the progress in attainment of targets			
3	Presence of clear and well-set out Targets But informed in an authoritarian way, and without feedback from the low levels		Targets aligned with Policy and Strategy			
			Define a system of monitoring and feedback			
4	Teamwork and with well-defined and well-set out Targets but possible competitive interferences between different Targets		That everyone knows everybody's Targets			
			That all the Targets are accepted			
			Define a system for revising Targets			
5	Well-defined, well-set out and accepted Targets, with revision system		Remarks:			

Table 2

4.1.2. Criterion 3: Improvement Groups

To obtain the general goals of the company, the individual ones of each Section must be met, which is why it is necessary to coordinate the work of the groups.

The Improvement Groups represent a possible way of encouraging individuals to contribute with their own intellectual resources to the attainment of the targets and goals set.

level	SITUATION	tick	ACTIONS PROGRAMMED TO GO TO NEXT LEVEL	Resp.	Date	Indic
1	There is no desire to start up a system of Improvement Groups		Start up a system of suggestions			
			Manage the suggestions			
2	It is desired to start up a system of Improvement Groups but only a System of Suggestions is available		Establish a Programme of Groups			
			Define forms for the suggestions			
			Inform and manage			

3	Groups exist or existed but with few suggestions or always from the same persons		Decided support of Management. Concrete plan			
			Training in Group techniques			
			System of short meetings for the subjects			
4	Improvement Groups and with active participation but lacking stability and progress		Informative meetings of the achievements of the Group			
			System of recognition of achievements			
5	Groups exist, which are active and stable		Remarks:			

Table 3

4.1.3. Criterion 5: Rapid changes

In the necessary coordination between the 20 different criteria, rapid changes of line, of dies, rollers, tile size, etc. are needed to reduce the cycle, delivery times, etc. which demands excellent maintenance and steady quality.

level	SITUATION	tick	ACTIONS PROGRAMMED TO GO TO NEXT LEVEL	Resp.	Date	Indic
1	The concept is not understood. The greater the lot, the fewer changes		Understand that overproduction creates wastefulness, unnecessary stocks and obsolescence			
			Define the needs of clients or of the store by means of logistics			
			Know the lots of different elements that take part in production			
2	In an initial phase and some persons understand it		Define product basics			
	The commercial team understands that it must be Logistics which determines the lots		Define minimum stock and optimum stock			
	Production understands that the 'economic lot' is not an applicable reality		Decide to create a Logistics department and make this responsible for production programming			
			Have cleaned out inventories			
3	The changing time is reduced in some machines		Have changing times in all the machines			
			Define the bottleneck of the changes			
			Break down the movements of all the machines during the change			
			Estudiar la optimización de movimientos			
			Informar y formar al equipo			
			Realizar una prueba en una línea			
4	The methods are used in the entire team		Systematise the changes by detailed technical instructions, which are known by everyone			
			Define targets in each machine change			
			Arrange the tools for rapid change			
5	The changes are made throughout the plant and in any machine		Remarks:			

Table 4

4.1.4. Criterion 8: Connected manufacturing

Nowadays a manufacturing system is needed that enables fabricating a wide range of products and small lots. The solution does not lie in having immense stocks of all the items to facilitate the production of larger lots.

CONNECTED manufacturing means functional communications and connections between processes. They are not necessarily physical (connections). The point is fully realising the 'client-supplier' concept. The needs are defined by the client, so that the supplier provides him with the necessary material, in the required amounts and defined time.

level	SITUATION	tick	ACTIONS PROGRAMMED TO GO TO NEXT LEVEL	Resp.	Date	Indic
1	The processes work independently		Training on in-plant materials flow			
			Know perfectly the materials flow throughout the operations			
			Control of maximum stocks in each section			
			Control de stocks máximos en cada sección			
			Stocks are clear and perfectly controlled			
2	The importance is understood of connecting processes		The connection points are the end and beginning of each operation			
	The need is known of defining an internal Client–Supplier system		It is needed to create improvement teams between contiguous sections			
3	Connection points are established		Process management is performed by means of these connection points			
			These connection points coincide with the operations			
			The entire factory participates in the improvement team			
			Introduce automatic systems at some connections			
			Everyone knows what happens at these points			
			The intermediate stock disappears at these points			
4	Connection points throughout the factory		The connection points by physical assembly are reduced			
			Special maintenance to create the single line			
	Work is being done on the idea of a single line		Need for adaptability			
			Need for flexibility			
5	Processes like lines		Remarks:			

Table 5

4.1.5. Criterion 12: Development of Suppliers

In order to achieve maximum efficiency in the internal processes, the collaboration of the suppliers is required in each one of the operations performed, in which their equipment or products take part.

level	SITUATION	tick	ACTIONS PROGRAMMED TO GO TO NEXT LEVEL	Resp.	Date	Indic
1	The relations are limited to purchasing and verification		Need to adopt the role of partners			
			The suppliers are an extension of the factory			
			Give maximum information and instructions to the suppliers			
			Form intermediate work groups			
			Active participation of suppliers in improvements			
2	The supplier is given technical support		Joint training in Value Analysis techniques			
	Maximum information to the supplier		System of mutual suggestions			
	Mixed work groups are formed		Maximum collaboration and open doors			
3	Support of engineering or R&D for the suppliers		Continuous improvement in materials and processes			
			Continuous improvement in materials and processes			
			The 20 keys system can help the relation			
4	Both are interested in the success of the 20 keys		Mutual support in programme development			
			Communicate the advances in both directions			
			Set priorities with committee			
			Joint training			
5	Joint achievement of 70 - 80 points		Remarks			
	Periodic exposition of the results					
	Mutual knowledge of the advances					
	The number of suppliers is reduced or highly reduced					

Table 6

These tables were used for in-plant diagnosis work, and the scores were noted down, identifying the starting state in regard to the particular key as well as the necessary steps to progress in the initially attained level.

The second part of the work involved verifying the implementation of the improvements and performance of a new evaluation.

4.2. THE OVERALL RESULTS OF ALL THE COMPANIES

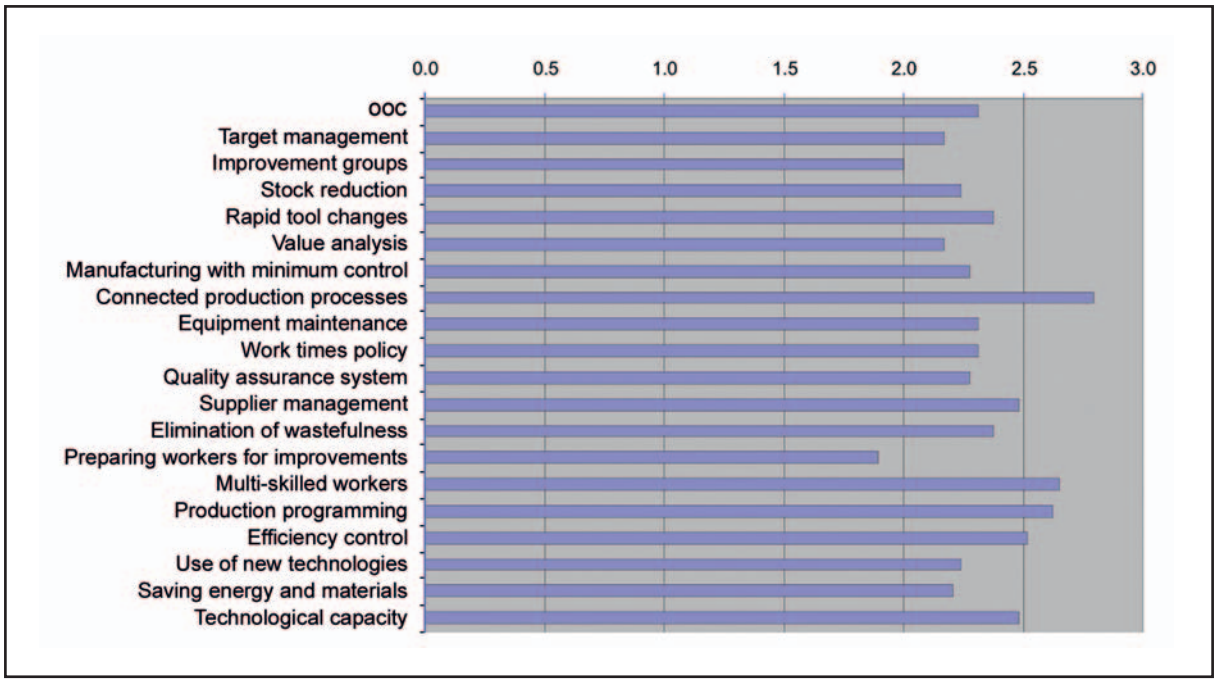

Figure 2. Overall results in the period 2002-2003

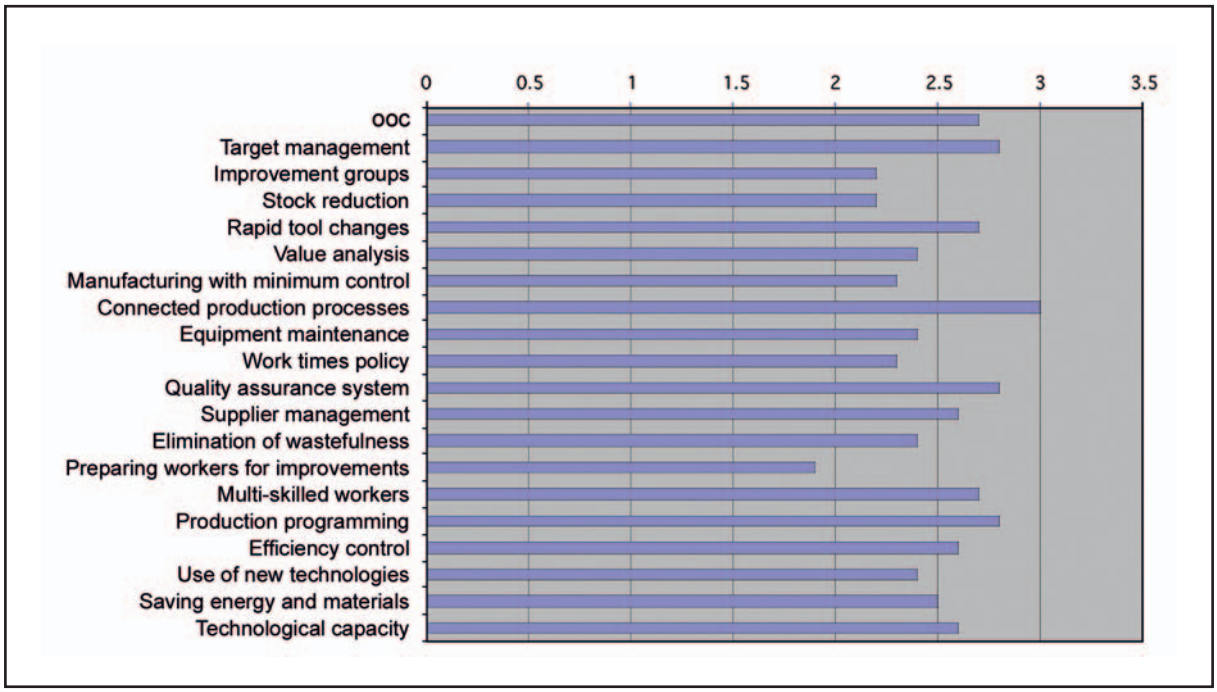

Figure 3. Overall results in the period 2004-2005

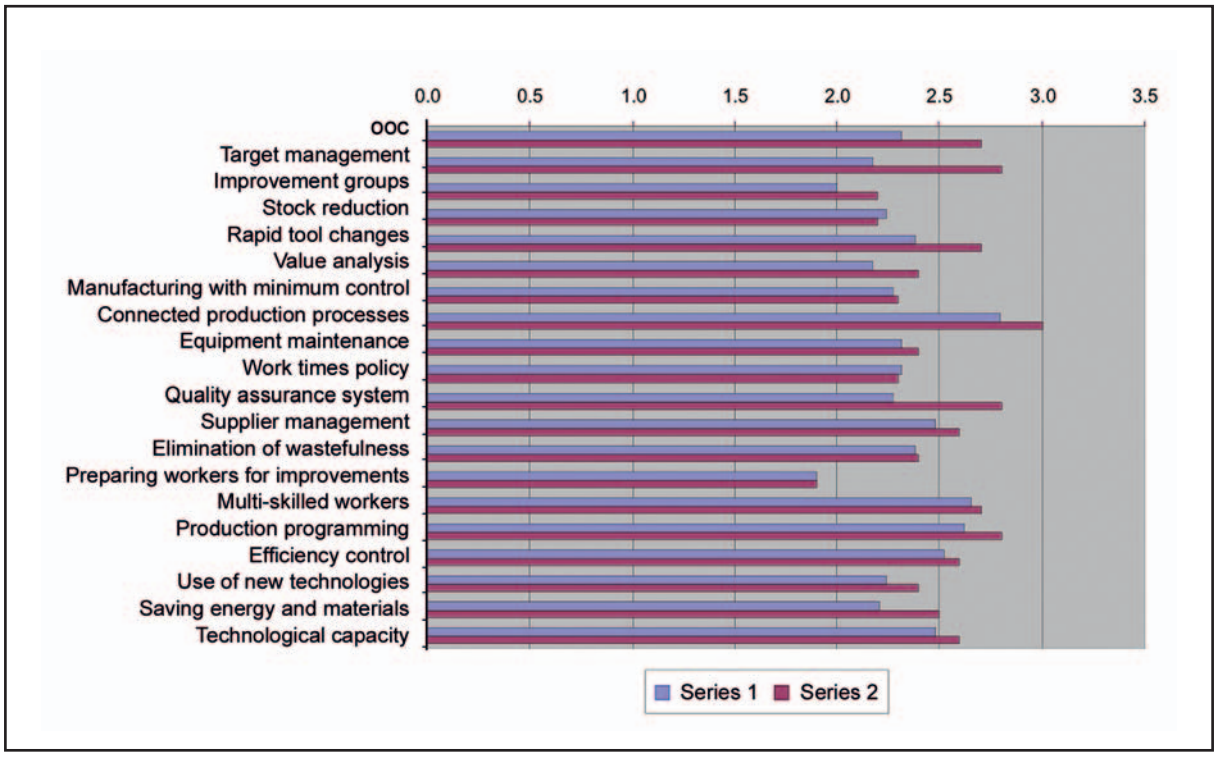

Figure 4. Comparison of both series 1(2002-2003) and 2(2004-2005).

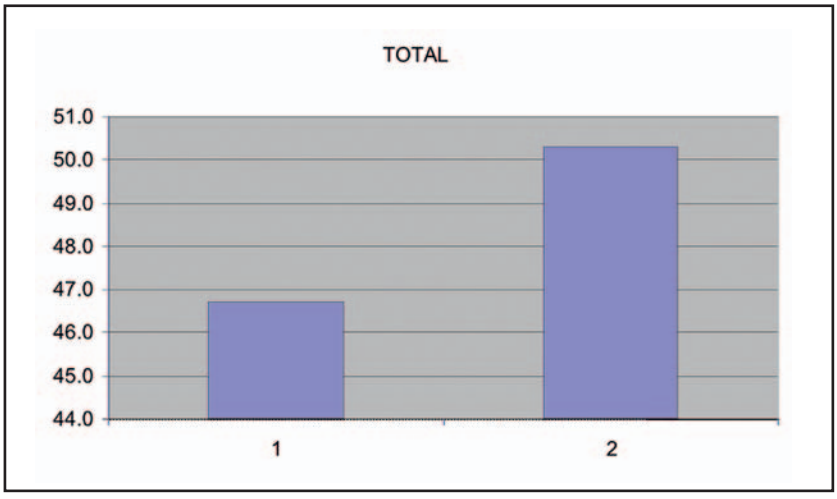

Figure 5. Total value in both series 1(2002-2003) and 2(2004-2005)

From these figures it may be concluded that the overall value, in both series, is relatively low and is located around 47-50 points out of an ideal total of 100, or out of one that is considered recommendable, of 80. The average score is 2.5 per key, with 5 as ideal score and 4 as recommendable.

The values with the best results (value above 2.5) in the first series (2002-2003) are:

- Connected production process
- Multi-skilled workers

- Production programming
- Efficiency control

The values with the worst results (value below 2.25) in first series (2002-2003) are:

- Preparing workers to make improvements
- Existence of Improvement Groups
- Value analysis
- Target management

An increase in the scores has taken place in this period of time. The overall improvement in the period between both series is about 10%, which is lower than expected, taking into account that problems were detected, establishing the original causes and the improvement actions to be introduced. The overall result in the last period still remains medium-low.

The improvement actions have produced advances in some of the factors:

Values that have improved most in this period:

- Connected production process
- Quality assurance system
- Target management
- Organisation and cleanness

However, there are still issues that have hardly been modified in this period:

- Stock reduction
- Policy of times
- Equipment maintenance
- Preparation to make improvements

In view of Figure 1, which establishes the interconnections of the model, it may be stated that the actions implemented and, in consequence, the overall scores obtained fundamentally lead to:

- **More rapidity** in the first place or preferentially (see improved keys 8 and 16).
- **Better quality** in the second place (see improved key 11), although not as intensively as the previous point.
- **Better cost** has practically not been modified

The rest of the improvements, in view of the scheme in Figure 1, affect the subjects below in the same measure:

- Target management

- Order and Cleanness.

Therefore, from an industrial point of view, the companies are more focused on rapidity in the work than on quality, although it is a subject that starts from higher values, and cost is the most sacrificed when it comes to planning industrial management. On this point it is necessary to note the relatively low values for maintenance management.

If we descend now to the singularities of the companies as far as breakdown criteria are concerned, it may be observed:

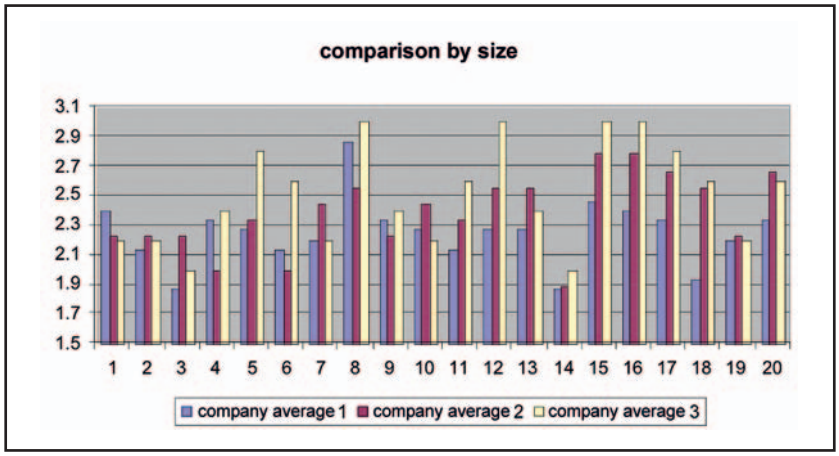

Figure 6. Comparison of the values in each key (from 1 to 20 on abscissas) between the three groups of companies (1: small installations; 2: intermediate installations; 3: large installations).

Higher values are found for the keys in the larger installations (more than 5 kilns), whereas in the intermediate and small ones there are higher or smaller values in one or the other.

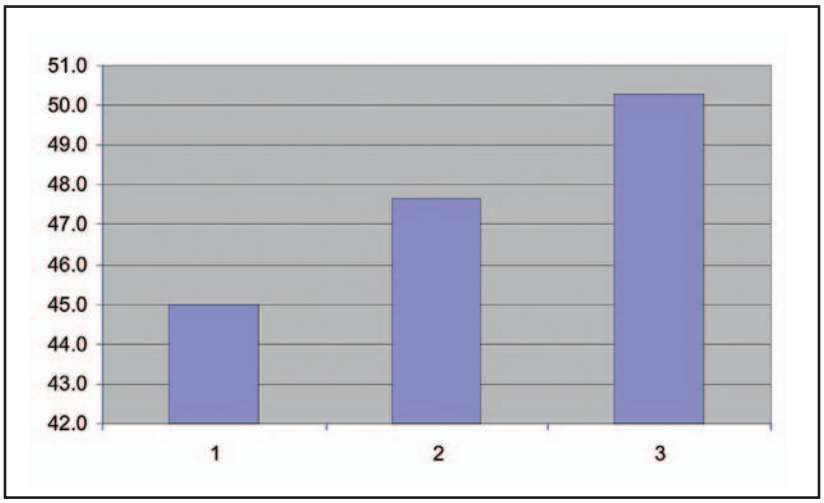

Figure 7. Total value of each group of companies (1: small installations; 2: intermediate installations; 3: large installations)

The commentary in this case is clear, since the overall result of factory management improves with factory size.

Figures. 8, 9 and 10 compare the three breakdowns to visualise the differences between results of the keys.

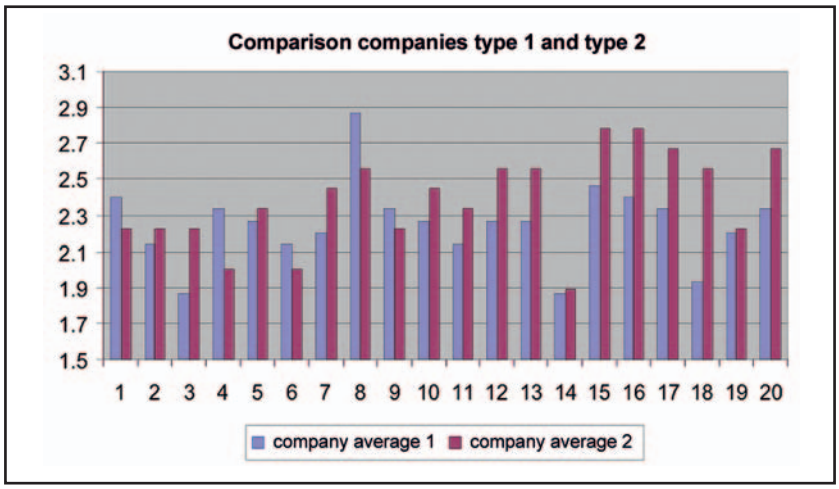

Figure 8

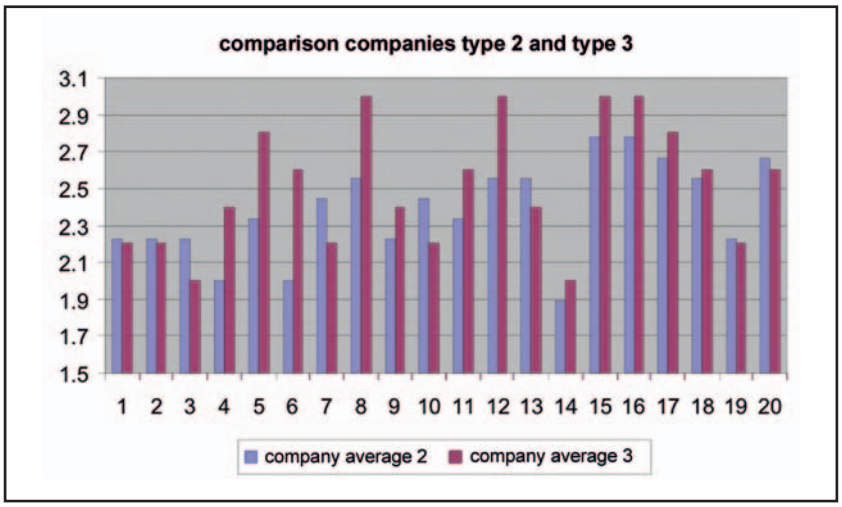

Figure 9

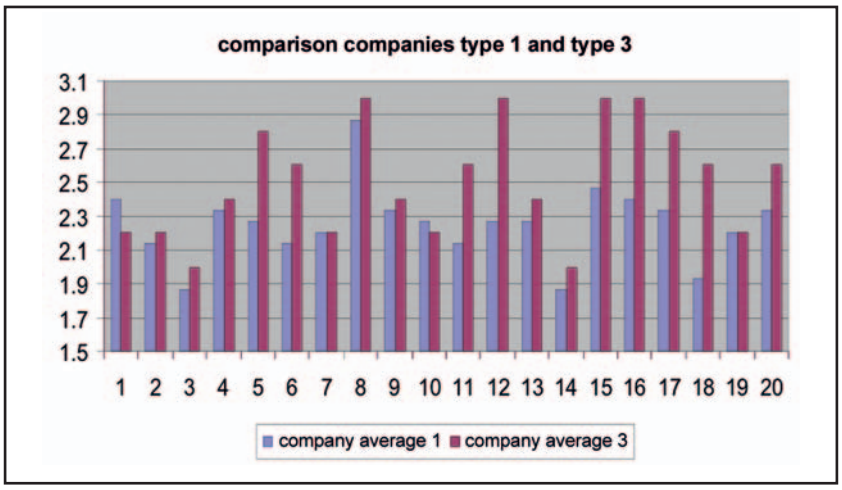

Figure 10

Figures 11, 12 and 13 compare each breakdown with the total obtained.

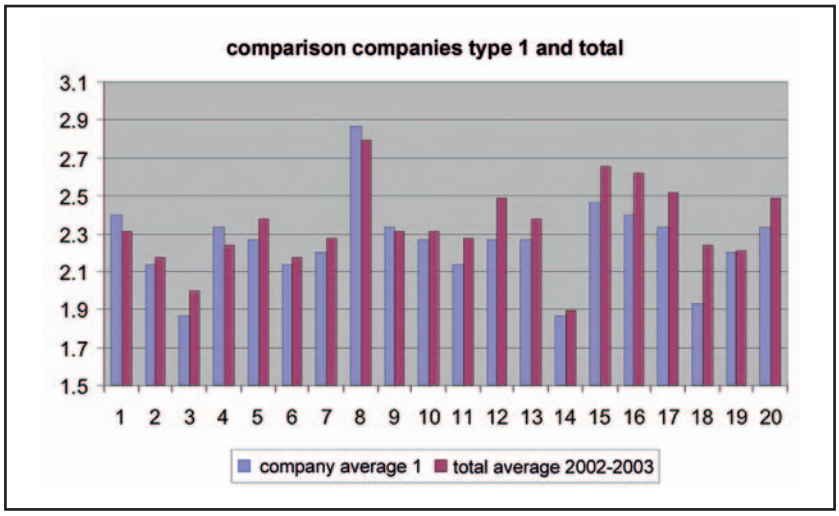

Figure 11

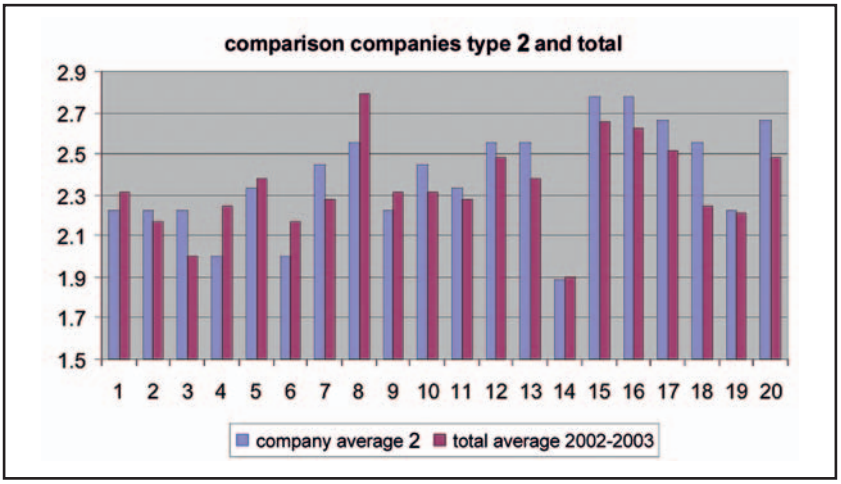

Figure 12

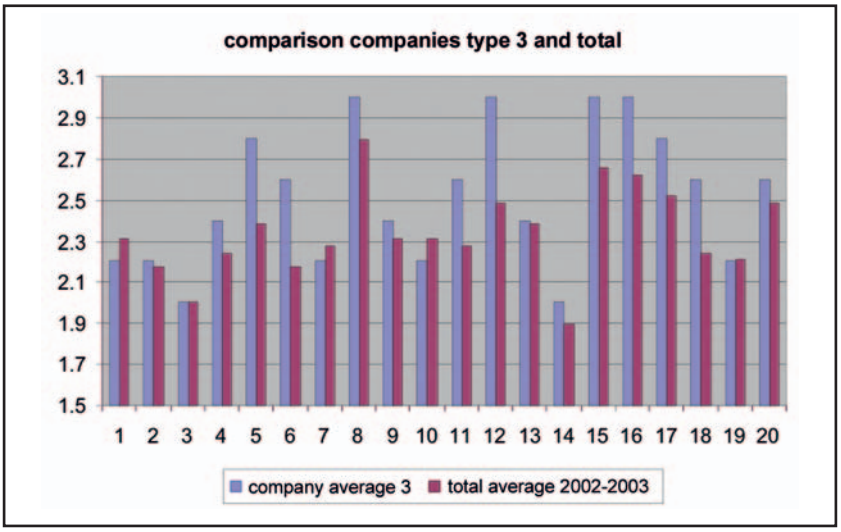

Figure 13

These 6 figures allow making a series of inferences:

- The companies in breakdown 1 (smallest) only display superior values to those of the other breakdowns in key 1 of Order and Cleanness.
- The companies in breakdown 2 (intermediate) display practically no key clearly superior to those of the other breakdowns.
- The companies in breakdown 3 (largest), in addition to a higher overall value, display superior values in the following keys:
  - Technologies of rapid tool change
  - Improvement of methods and value analysis
  - Quality assurance system
  - Development of suppliers
  - Training in versatility
  - Compliance with programming
- The companies in the three breakdowns display similar values in:
  - Target management
  - Maintenance management
  - Policy of times
  - Eliminating waste
  - Training to make improvements
  - Conservation of energy and materials
  - Technological capacity
- The remaining keys display no defined orientation.
- Taking the comparisons now one by one between the different breakdowns and taking breakdown 3 (the largest) as the best one in the sample, it may be observed:
  - The points to be improved in breakdown 1 (smallest) are:
    - All in general
    - In particular:
      - Rapid change technology
      - Improvement of methods and value analysis
      - Development of suppliers
      - Training in versatility
      - Compliance with programming
      - Efficiency control
      - Use of computers

- Technological capacity

- The points to be improved in breakdown 2 (intermediate are.
  - All in general
  - In particular:
    - Stock and works in course
    - Technology of rapid tool change
    - Improvement of methods and value analysis
    - Connected manufacturing
    - Development of suppliers
    - Training in versatility
    - Compliance with programming

In view of all the results, factory management in the ceramic tile companies requires putting in place a series of improvements aimed, fundamentally, and in this order at:

- Improving Cost:
  - Improvement of methods and value analysis
  - Efficiency control
  - Training to make improvements
  - Improvement of maintenance management
  - Policy of times
- Improving Quality:
  - Improvement of maintenance management
  - Development of suppliers
- Improving Rapidity:
  - Technologies of fast tool change
  - Training in versatility

In order to achieve the foregoing, in accordance with the scheme in Fig. 1, it will also be necessary to introduce drastic improvements in:

- Organisation, order and cleanness
- Target management
- Work by Improvement Groups
- Technological capacity

5. CONCLUSIONS

- A significant sample of manufacturing floor and wall tile companies have been analysed from the point of view of the 20 keys to industrial improvement.
- They have been analysed in direct fieldwork, in two different periods, to evaluate the degree of advance in the 20 keys.
- For this purpose, a preliminary study was conducted to adapt the theoretical model to the reality of the companies involved.
- A breakdown was made of the companies to allow in-depth analysis of the differences, together with tendencies based the industrial size of the factory.
- Conclusions are drawn in the definition of the strong points and areas for improvement, for the entire sample and for the breakdowns.
- The evolution observed in the studied period, although important, does not involve a radical advance that would enable observing significant improvements as a whole.
- The keys that received the best scores were essentially the ones that affected the industrial concept of RAPIDITY, followed by those of QUALITY, with scarce influence of the ones related to COST.
- The main advances will need to occur in this last concept, although there are evident possibilities for improvement in all the keys as a whole.
- There is an infrastructure for appropriate industrial management (Technological capacity, know-how in efficiency control, development of suppliers, quality assurance system and presence of information technologies)
    - It remains necessary to develop important internal aspects, which may be divided into two blocks:
        - The ones that affect human resources:
            - Training in versatility
            - Development of Improvement Groups
            - Training to develop Improvement actions
        - The ones that affect internal management:
            - Maintenance
            - Improvement of methods and value analysis
            - Control of intermediate stocks
            - Policy of times
            - Development of suppliers
            - Technology of fast tool change
    - All the foregoing together, in addition to:
        - The necessary definition of Targets, knowledge of Targets, monitoring and Target alignment with Policy and Strategy.

- It cannot be disregarded that there are companies with that score 66 points, as opposed to others with 44. This is indicative of the potential for improvement, starting off with situations known and applied by other companies.
- The results obtained and the plans put in place suggest that the objective of achieving scores of 65-70 points is attainable in a period no greater than 4 years, which would effectively influence the industrial competitiveness of the companies.

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