Standardisation for incremental innovation: a case study in the Brazilian automobile industry

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Abstract: This paper argues that formalism and standardisation are essential elements to stimulate incremental innovation in the operating core of manufacturing firms. Kaizen and total quality control are adopted as reference practices as they ensure a high level of compliance to formal rules and a great degree of commitment to a constant and systematic process of revising old standard, which results in the creation of an institutional framework that favours incremental innovation. This allows manufacturing firms to reap benefits from workers' creativeness in the long run. In addition, a case study conducted from October 2006 to October 2008 in a car assembler in Brazil identifies the lack of enforcement of formal rules and the absence of compliance to systematic procedures towards the revision of standards as the main obstacles for incremental innovation in the Brazilian automobile industry.

Keywords: standardisation; formalism; kaizen; total quality control; TQC; institutionalisation; incremental innovation.

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1 Introduction

This paper argues that formalism and standardisation are essential elements to stimulate incremental innovation in the operating core of manufacturing firms. It proposes a model for incremental innovation and shows that, although a certain level of flexibility is

necessary in order for blue-collar workers to implement changes in the manufacturing process, formal rules are paramount for consolidating such changes and for creating an institutional framework that favours the appropriation of benefits from workers' creativeness in the long run. Additionally, this study identifies the lack of enforcement of formal rules and the absence of compliance of workers to systematic procedures towards the revision of standards as the main obstacles for incremental innovation in the Brazilian automobile industry.

This present research draws on North's (1990) theory of institutionalisation. His discussion on the historical evolution of economies shows that the structure of incentives of a given society determines the direction of institutional evolution. Based on this theory, kaizen and total quality control (TQC) were adopted as reference practices for evaluating the Brazilian automobile industry because, through such practices, Japanese automakers were successful in building an organisational culture whose incentive structure favours the development of a work environment propitious for constant institutional change. These practices promote flexibility, encouraging blue-collar workers to implement innovative changes, while providing consistent mechanisms to incorporate such changes into formal rules. They thus favour the continuous revision of old standards and the development of new ones, which are key elements in the incremental innovation process.

This paper contributes to the literature on Organisational Theory by presenting evidence to sustain that formalism is not a hindrance to innovation, but an important element for comprehensively appropriating the benefits of workers' creativeness. In studies focused on Brazilian organisations, authors such as Trevisan and Carvalho (2003), O'Keefe and O'Keefe (2004) and Tanure (2005) contend that the Brazilian management style and organisational culture leave considerable space for adaptability, resulting in high levels of flexibility to deal with unforeseeable situations at the work place. Nonetheless, this present paper argues that Brazilian organisations may not be reaping benefits from workers' innovative solutions in the long run due to the lack of a consistent process of enforcing formal rules and work procedures. As a result, innovative solutions are applied only to particular cases, are not comprehensively used to similar situations and do not lead to knowledge accumulation and diffusion. In such circumstances, adaptability may not lead to incremental innovation.

This paper is divided into five sections, including this introduction. The following section presents the conceptual framework. Section 3 proposes a model for incremental innovation. The fourth section is dedicated to the case study, followed by the conclusion.

2 Conceptual framework

North (1990) defines institutions as "humanly devised constraints that shape human interaction" and "reduce uncertainty by providing a structure to everyday life". Institutions can be divided into formal (constitutions, laws, property rights, etc.) and informal rules (customs, traditions, codes of conduct, etc.). By comparing the historical development of different societies, North (1991) argues that "institutions provide the incentive structure of an economy", and as this structure evolves, "[it] shapes the direction of economic change towards growth, stagnation, or decline". Different incentive structures resulted in different patterns of evolution of the institutional framework of societies, leading to the perpetuation of patron-client relationships in some countries

or to a gradual evolution towards impersonal relationships in business transactions in others.

North's discussion on institutional change is focused on the analysis of the historical evolution of societies, describing the role of states, merchant's guilds and culture in shaping this gradual transformation of the institutional framework at the macro level. Nonetheless, the importance of such institutions can also be observed at the micro level, within organisations. The relevance of formal rules in organisations to create a more controllable environment and to achieve a high level of predictability of employees' behaviour was well described by Weber (1947). Informal norms of interaction also shape human behaviour at the work place and are equally important. The interplay between formal rules and informal norms creates the incentive structure of an organisation and shapes institutional evolution.

Kaizen and TQC are practices adopted by Japanese automakers which have been consolidated by both formal rules and informal norms and create a work environment propitious for institutional change. Such practices are focused on developing a sense of commitment in the workforce towards the need for continuously reducing non-value-added tasks and improving work processes.

2.1 Institutional change in the operating core of Japanese automakers

From the mid-1980s onwards, a vast literature on organisational studies, including authors such as Womack et al. (1991), Fujimoto (1999) and Cusumano and Nobeoka (1998), has highlighted the advantages of the production system developed by Japanese automakers, in particular regarding their capacity to implement a number of practices to promote continuous improvements and proactively respond to external threats.

For Imai (1986), the main reason for the success of Japanese automakers is the practice of kaizen, in which workers constantly search for non-value-added activities during their everyday jobs, eliminating unnecessary tasks and promoting small improvements.

There are at least eight major types of non-value-added activities in manufacturing:

1 overproduction: manufacturing items for which there is no order

2 waiting: workers having to stand around waiting for the next processing step

3 unnecessary transport: inefficient transportation or carrying materials over long distances

4 incorrect processing: inefficient processing caused by poor product designs or taking unnecessary steps to process parts

5 excess inventory: stocking excessive finished goods or raw materials

6 unnecessary movement: the time workers have to spend searching for tools during their work

7 defects: producing defective components resulting in rework

8 unused employee creativity: losing skills, ideas, and learning opportunities by not listening to workers (Imai, 1986; Liker, 2004).

Under kaizen, the workforce makes continuous efforts to eliminate such types of non-value-added activities, aiming at an ideal situation of perfection. In this manner, kaizen is better defined as a principle or philosophy, rather than a practice.

Kaizen is connected to the idea of "ongoing improvement, involving everyone" (Imai, 1986), including top management, managers and blue-collar workers. The philosophy of kaizen, therefore, assumes that work processes and the final product can always be improved and the entire workforce should be constantly committed to finding ways to promote ameliorations. Furthermore, participation in kaizen activities is said to develop new knowledge, skills, and abilities that may be applied to subsequent problem-solving tasks (Womack and Jones, 1996, Hicks, 2007, Farris et al., 2009).

Thus, workers in the operating core of Japanese automakers are constantly trying to improve the manufacturing process by implementing minor changes in their daily work. Their suggestions of improvements are implemented tentatively before being officially and formally adopted by the automaker. Through the adoption of kaizen, therefore, the automaker maximises the trade-off between efficiency and flexibility by creating an organisation structure that is, at the same time, bureaucratic – i.e., relying on norms, standardisation and hierarchy –, and organic – that is, favouring employees active participation and innovation (Adler et al., 1999). Kaizen creates a routine procedure in which employees are motivated to constantly work towards refining formalised procedures. As a result, blue-collar workers themselves become partially responsible for job design and redesign.

The kaizen philosophy is evident in TQC. In the so-called quality control circles, workers are divided into teams and are expected to collectively identify problems and suggest ways to improve the manufacturing process (Womack et al., 1991). Such circles follow a standardised sequence starting from the recognition of a problem, "moving on to root-cause analysis, generation of an alternative action plan, evaluation of alternatives in terms of problem-solving capabilities, recommendation of a new way of doing the task, and prevention of the same problem again" (Fujimoto, 1999). Quality control circles thus work as a systematic mechanism for revising old standards and suggesting new approaches, through standardised procedures for problem diagnosis and problem solving.

Moreover, the idea of TQC is characterised by its comprehensive approach, which encompasses non-manufacturing departments of the firm, such as product design, marketing, sales and after sales, involving the entire workforce. Under this approach, the responsibility of maintaining quality is transferred from inspection personnel or quality control staff to the workforce, especially to workers in the operating core (Cusumano, 1985, Imai, 1986). If one considers that the capacity of managers to make effective decisions is limited by bounded rationality (Simon, 1991, Conner and Prahalad, 1996), the involvement of the entire workforce in quality control driven activities is of a significant importance.

Furthermore, quality control efforts in Japanese firms are consumer-oriented and therefore are not restricted to inspection for defective components. The whole process is focused on improving the final product in order to better address the needs of customers. It is thus clear that quality control measures are intrinsically connected to the kaizen philosophy.

The success of kaizen and TQC requires a process-oriented management control system, which does not strictly emphasise the achievement of short-term quantitative results, but rather stresses the need to motivate and award workers' commitment to the continuous improvement of quality standards. Accordingly, education and training are

essential to develop a multi-skilled workforce with a comprehensive view of the production process and thus capable of identifying and solving problems on-the-spot to improve their everyday work (Imai, 1986).

The 5S approach, which is a collection of simple activities that should be followed by workers to maintain order, discipline and a clean environment in the operating core, is an example of a practice focused on developing the kaizen mentality on the shop floor. 5S stands for the initials of five words in Japanese connected to the idea of discipline and cleanliness – Seiri: arrangement, Seiton: order, Seiso: cleanliness, Seiketsu: neatness, Shitsuke: discipline. Through the 5S approach, many sources of errors, defects and injuries can be eliminated. Shitsuke is connected to the idea of sustainability and therefore workers must have discipline to follow the 5S approach, constantly trying to reduce the sources of waste (Liker, 2004).

For the development of a multi-skilled workforce, blue-collar workers are expected to rotate to different work stations in order to develop skills to handle different tasks as well as intellectual skills – i.e., a type of acquired knowledge concerning the structure of the machine and the way to treat unusual situations and problems. According to Koike (1988), in Japan, blue-collar workers have to regularly attend off-the-job training in which they learn much of what is deemed white-collar work. On-the-job training is also widely used to directly transfer skills from veterans to newcomers. As a result, blue-collar workers develop a wide range of skills, including not only operating assembly machines and handling maintenance tasks, but also dealing with unforeseen situations. Moreover, a higher level of flexibility can be achieved by developing a multi-skilled workforce, since workers can be relocated to other work teams according to fluctuations in demand (Shimokawa, 1994).

Japanese automakers place a great importance on the operating core. As Fujimoto (1999) points out, for instance, new equipment created by engineers at Toyota are only used in factories after being approved by blue-collar workers, an evidence of what he calls *genba-shugi*, i.e., shop floor sovereignty. Through off-the-job and on-the-job training, blue-collar workers acquire a comprehensive view of the production process in order to continuously search for and eliminate non-value-added tasks and actively participate in quality control circles. The small but constant changes implemented by them result in large enhancements of the production system in the long run. Japanese automakers thus focus on incremental innovation, a process which is based on the kaizen philosophy and is put into practice through TQC.

The commitment to a constant process of reducing non-value-added tasks is essential for enabling the revision of obsolete rules and standards. By implementing systematic revision procedures and developing a kaizen mentality in the shop floor, Japanese automakers successfully created an institutional framework which provides incentives for incremental innovation.

3 Modelling incremental innovation

Abernathy (1978) distinguishes two types of innovation: radical and incremental[1]. While the former introduces a totally new design approach, resulting in a disruptive change in the evolution of the previous one, the latter is characterised by minor but significant improvements that shape the direction of existing design approaches. Despite the relevance of radical innovation, he contends that "it is misleading to judge an innovation

by its apparent novelty". According to him, "incremental innovation has been very important because it is cumulative and because it builds on existing approaches".

This section proposes a model outlining the main elements and stages of incremental innovation. The model reveals the importance of standardisation and formalism for reaping benefits of workers' creativeness in the long run and for enabling incremental innovation in the operating core of manufacturing firms.

The development of the so-called black box parts system in Toyota illustrates the importance of formal rules and standardisation. The black box parts system is characterised by an increasing participation of first-tier suppliers in product design and development, based on the automaker's specifications. According to Fujimoto (1999, p.153), this system emerged in Toyota and Nissan approximately at the same time, but the former was much faster in implementing it because rules were created to standardise and diffuse the system, while the latter kept it only as an informal practice. In fact, he regards "regular problem solving and systematic documentation of the results" as "essential components for retention of routines, and thus for a company's internal evolutionary mechanism". He therefore questions the dichotomy between bureaucracy and innovation, arguing that "repetition (i.e., standardization) and retention (i.e., organizational memory in the form of documents and others) are basic elements of the evolutionary process" [Fujimoto, (1999), p.267]).

Formal rules in a bureaucracy are rationally designed to achieve specific goals or objectives and should therefore be enforced. They are necessary not only to set standards, enabling workers to perform their tasks efficiently, but also to create systematic procedures, allowing them to identify obsolete rules or standards and revise them.

It is true that Merton (1957) discussed some of the so-called bureaucratic dysfunctions, which are inefficiencies originated from an excessive devotion of workers to formal rules. According to him, bureaucratic structures tend to demand reliability of response and strict obedience to regulation. After a long period of adherence to certain rules, workers may get accustomed to repeating the same procedures and start following such rules only as a habit or ritual, which can prove to be counterproductive. Under such circumstances, compliance to formal rules becomes a mere habit and not an instrument to achieve an objective. This is what he calls 'displacement of goals', i.e., a situation in which following regulations becomes an end in itself and not a means to achieve the organisational goals. Another example of bureaucratic dysfunctions is 'trained incapacity', when actions that have been successfully applied in the past are internalised by the worker and result in inappropriate responses under changed circumstances. Nonetheless, such dysfunctions are not evidence of the incompatibility of formalism and innovation, but rather reveal the necessity to constantly revise and update formal rules.

For a successful process of updating obsolete formal rules, the development of a kaizen-driven mentality is paramount. Although adherence to standards as well as conformity to formal rules and work procedures should be enforced, it is equally important to train blue-collar workers to develop a mindset constantly trying to identify problems in the production process and search for solutions.

Additionally, a process-oriented management control system should be adopted to ensure the compliance of workers to this systematic process of problem-diagnosis and problem-solving. Rather than evaluating the performance of workers based exclusively on quantitative results, it is necessary to get their commitment to the process itself, so that they can develop a kaizen mentality.

Hence, the main elements of incremental innovation are:

1 formal rules to set standards

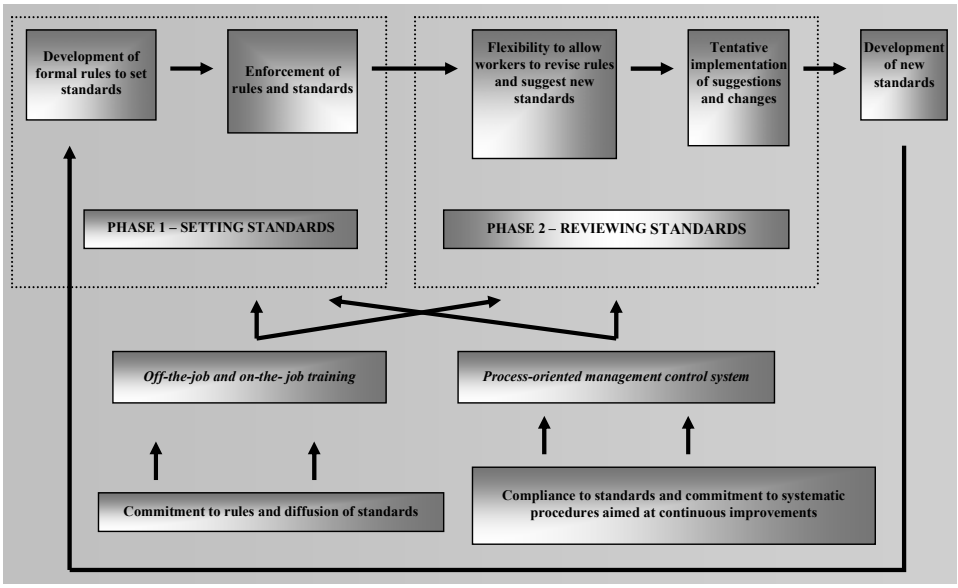
2 on-the-job and off-the-job training to enforce the compliance to standards and work procedures

3 a Kaizen mentality to constantly revise obsolete rules

4 process-oriented management control systems to create a sense of commitment to a systematic process of identifying and eliminating obsolete standards

5 the consolidation and diffusion of revised standards through new formal rules.

Figure 1 Incremental innovation in the operating core of manufacturing firms



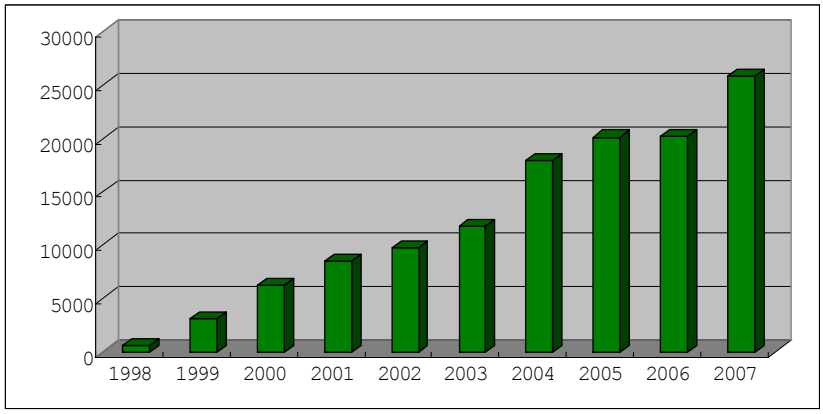
The model shows that workers should be trained to follow work procedures, rules and standards, as well as to actively take part in the process of improving and revising such rules. The process of participation itself, through quality control circles, follows a systematic and standardised methodology as a way to comprehensively incorporate workers' new ideas in the production process. In this manner, the firm stimulates incremental innovation in its operating core and minimises the risk of rules obsolescence.

4 Case study

A case study was conducted from October 2006 to October 2008 in a Brazilian domestic company called MMC Automotores do Brasil Ltd (MMCB), which was founded in 1996 and assembles Mitsubishi automobiles. The objective was to identify the obstacles for a successful process of incremental innovation in the operating core of this automobile assembler. For this purpose, in-depth interviews were conducted with factory personnel,

including the logistics manager, and a fieldwork trip was made to the factory, located in the municipality of Catalão, in the state of Goiás. During the fieldwork, data was collected regarding the recruitment process, on-the-job and off-the-job training and the educational background of the blue-collar workers. The level of commitment of MMCB workers to kaizen and TQC activities was also assessed. Overall, the case study demonstrated that the implementation of such practices was still on a primitive level and that the company had excess inventory, low productivity, and relied mostly on final inspection of assembled vehicles for defect detection.

Figure 2 MMCB vehicle production per year in units (see online version for colours)

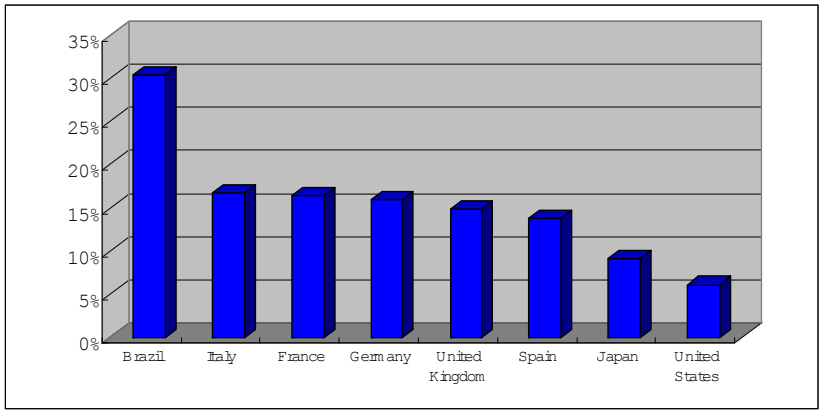


Source: Anfavea (2008, p.117)

The Brazilian automobile industry is a relevant sector in the Brazilian economy, which generated an estimated 1.5 million direct and indirect jobs in 2005. In 2007, Brazil was seventh in worldwide vehicle production, with 2,977,150 units, and this industrial sector was responsible for 18% of the country's industrial GDP (Anfavea, 2008). The surveyed company MMCB had, in 2007, 1,974 employees, a total area of 650,000 square meters and assembled 25,844 vehicles. Although an increase in productivity can be observed since 1996 (Figure 2), the company is responsible for less than 1% of the total industrial output of the Brazilian automobile industry.

The municipality of Catalão, in which MMCB is sited, is remote from São Paulo, the industrial center of Brazil and the state in which most of the suppliers are located. In fact, MMCB's main warehouse is situated in Osasco (approximately 690 km from Catalão) and the imported engines and auto parts are discharged at the port of Santos (770 km from Catalão), both cities located in São Paulo. Although such a distance generates logistical problems for the company, MMCB personnel affirmed that Catalão was chosen for the location of the factory due to several financial incentives provided by the local government, especially the reduction of the import tax and the value-added tax on the circulation of goods called ICMS. The impact of taxation on vehicles' final price in Brazil is high, which explains why tax exemptions play such an important role on the decision regarding factory location in Brazil.

Figure 3 Tax burden on vehicles in selected countries (see online version for colours)



Source: Anfavea (2008, p.45)

MMCB was engaged in very limited R&D activities and tended to rely on lower-order competitive advantages, such as low labour costs and governmental financial incentives, to increase its participation in the Brazilian market. This is not a solid strategy in the long run, as the company may be outrun by other automakers in Brazil or by factories located in other emerging economies offering more attractive manufacturing conditions.

The minimum requirement for the recruitment of blue-collar workers at MMCB was a secondary education and their training process started with a compulsory course on quality control. After that, they worked for one month side-by-side with a veteran. By the end of the one month period, they were supposed to take a practical test and, if approved, they could start working at a specific workshop. All blue-collar workers initially rotated within a five-person work team and then were transferred to different shops.

However, no effort to provide a continuous training process was observed at MMCB. The company did not offer additional courses for updating workers' skills and for developing the necessary abilities to search for and eliminate non-value-added activities. In fact, workers waiting idly were observed in some of the company's facilities, particularly in the warehouses which provided components just-in-time for the assembly line. This demonstrates that the company was not trying to effectively use its multi-skilled workers to control fluctuations of demand. It also shows the lack of commitment of the workforce with the reduction of non-value-added tasks. An effective process-oriented management control system is needed to encourage workers to search for ways to improve the production process.

MMCB also provided limited real-time information to blue-collar workers. The most valuable source of data was a real-time on-line system that could be accessed by managers through computer terminals. This system showed all necessary information for monitoring the production process, such as: the number of defective cars; the stage that each car was at and the stage it should be at the assembly line; and the total number of produced cars. However, information available to blue-collar workers was restricted to: boards showing the correct way to assemble components; signs warning about common mistakes; and a large signboard at the end of the assembly line displaying the number of

produced cars and the expected productivity for the day. Japanese automakers, on the other hand, acknowledge the importance of providing real-time information to blue-collar workers as a way of improving their participation in quality control circles. The importance of providing such kind of information to the operating core becomes evident when one considers that TQC rely on defect prevention and on-the-spot inspection by blue-collar workers, rather than final inspection of assembled vehicles. By overlooking the importance of blue-collar workers' training and by not providing the necessary real-time information for the shop floor, MMCB was losing possibilities of improving quality control and defect prevention.

The fact that the company had to conduct throughout inspections of assembled automobiles demonstrated the reliance on inspectors and quality control personnel for defect prevention and for ensuring compliance to quality standards. The lack of real-time information available to blue-collar workers and the reliance on final inspection of assembled vehicles for quality control show that MMCB was not adopting a company-wide quality control program focused on the entire workforce and did not try to develop a kaizen mentality in the operating core.

MMCB workers attended courses on electronics and mechanics provided by a Brazilian organisation for vocational training called SENAI (National Industrial Training Service) and were not initially trained directly by the company (Ribeiro, 2005). MMCB should therefore introduce more training programmes as a way of encouraging employees to play a more active role in improving manufacturing processes. The great level of involvement of blue-collar workers as observed in Japanese automakers can only be achieved through a mixture of on-the-job and off-the-job training that goes far beyond the acquisition of basic knowledge of electronics and mechanics. Company specific training is important to develop an organisational culture that ensures the workforce's commitment to continuous improvements and quality control.

In fact, the philosophy of promoting continuous improvements is part of the institutional framework developed by Japanese automakers that provides incentives for a constant process of institutional change. Kaizen creates an environment and organisational culture that compel the workforce to constantly improve the company's products and internal processes, even in periods of prosperity and without any apparent external threat. Since the philosophy of kaizen was not diffused in MMCB, the company was not making use of workers' creativity and ideas to improve the production process.

Contrasting fieldwork data with the model presented in the previous section, it is possible to identify the main obstacles to incremental innovation in the surveyed company MMCB. Terms such as kaizen, TQC and 5S approach were widely mentioned during the interviews, especially by the logistics manager. Actually, a board containing a brief explanation of the 5S approach was observed in one of the facilities of the company. Therefore, the main issue was not acknowledging the importance of such practices or creating formal rules for their implementation. The main obstacle tended to be enforcing such rules in order to ensure the compliance of blue-collar workers to standards. The lack of on-the-job and off-the-job training on a regular basis to explain formal rules and consolidate standards decreased the workforce compliance to predefined work procedures. Additionally, there was no evidence of the use of process-oriented management control systems, hindering the development, in the operating core, of a mindset methodically oriented towards the identification and solution of manufacturing problems.

In the absence of process-oriented management control systems and commitment to rules and standards, the process of reviewing old standards and creating new ones (Phase 2 of Figure 1) is disrupted. In this context, even if a certain level of flexibility is given to the workforce to participate, the number of suggestions may not be significant and relevant solutions voiced by workers will only be applied to particular cases. Due to the lack of an institutionalised process of reviewing and updating rules and standards, good ideas proposed by the workforce were not being comprehensively incorporated by MMCB as new rules or standards. As a result, innovative suggestions were not leading to knowledge accumulation and diffusion.

5 Conclusions

This paper proposed a model for incremental innovation and demonstrated that formalism and standardisation are essential requirements for this process to take place in the operating core of manufacturing firms. Additionally, by contrasting the model with data collected through a case study conducted in a Brazilian private automaker, this study showed that the main obstacles for incremental innovation in Brazilian manufacturing firms tend to be the lack of enforcement of rules to ensure compliance of blue-collar workers to a comprehensive procedure of identifying and solving problems in order to promote continuous improvements.

Authors such as Trevisan and Carvalho (2003) and Tanure (2005) identify flexibility and adaptability as features of Brazilian culture and contend that such characteristics are useful in dealing with unforeseeable situations or overly strict norms in the work environment. Nonetheless, the case study revealed a lack of standardised problem-solving activities for the revision of obsolete formal rules and for dealing with unexpected situations in MMCB. In the absence of such procedures, even if the workforce is characterised by a high level of flexible, adaptable and innovative behaviour and workers do find innovative solutions for manufacturing problems, their ideas may not lead to incremental innovation because each devised solution is only applied to a particular case and is not comprehensively adopted by the organisation. In this context, innovative solutions may not lead to the revision of old rules and standards or to improvements in work processes. Additionally, in the lack of standardised procedures to act in response to unusual situations, the organisation leaves too much room for discretionary decisions of blue-collar workers, which may have a negative impact on ordinary or regular activities. Hence, when there are no mechanisms to standardise and diffuse solutions proposed by workers throughout the organisation, companies may find it more difficult to benefit from workers' creativeness.

Finally, it is worth mentioning that, although kaizen activities emerged in the automobile industry, they are applicable to a wide range of manufacturing firms (Farris et al., 2009). The discussions presented in this paper are thus also relevant to manufacturing firms in other industrial sectors. Moreover, Levitt (1972) demonstrated the possibility of applying a production-line approach to the services sector and, therefore, the importance of standardisation and formalism to incremental innovation also tends to be valid for firms in the services industry.

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Notes

1 To these two types of innovation, Abernathy and Clark (1985) and Henderson and Clark (1990) include a third one, architectural innovation, which is a type of "innovation that changes only the relationships between [the core design concepts]", leaving "the components, and the core design concepts that they embody, unchanged". Architectural innovation is intrinsically connected to the concept of modularisation (Baldwin and Clark, 2003; Doran, 2003). This type of innovation is, however, out of the scope of this paper.