Internationalisation of Lean Manufacturing: The Influence of Environmental Conditions

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Abstract In the last decades many manufacturing firms have launched lean internationalisation initiatives so as to develop high performance foreign subsidiaries and/or suppliers. Several worldwide cases of successful lean adoption suggested the power as well as universality of this managerial method, thus motivating firms to diffuse their knowledge towards geographically-dispersed partners. However, previous projects also shown the difficulty in internationalising lean manufacturing, which sometimes even precluded its effective transfer. In fact, as advocated by some scholars, lean implementation effectiveness can be affected by environmental differences between countries. Although previous studies pointed to several inhibiting factors for lean internationalisation and provided some evidence of their negative impact on diffusing lean management across different countries, the literature is still lacking a holistic framework explaining such relation. In the attempt to provide a more comprehensive examination, this study takes a broad view on factors describing the international environmental conditions—i.e., socio-cultural, political-legal, economic, and educational dimensions—and analyzes their influence on lean internationalisation projects, in terms of problems in diffusing internally related as well as externally related lean practices. To this purpose, we conducted a single in-depth case study concerning two lean internationalisation projects launched by an Italian manufacturer so as to diffuse its lean knowledge towards a Chinese peer subsidiary and suppliers, respectively. Findings from the study can support managers in acknowledging the main criticalities in the internationalisation of lean manufacturing as well as in better understanding reasons behind them, thus helping to reduce lean internationalisation projects' failures.

Keywords Lean manufacturing · Global operations management · Knowledge diffusion

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1 Introduction

In the last decades, globalisation has led a growing number of manufacturing firms to internationalize their operations. In order to attain a superior competitive advantage, some manufacturers have taken a global view in selecting suppliers and/or choosing markets in which sell their products; in some cases internationalisation has also resulted in the establishment of new production facilities in geographically-dispersed countries. A new challenge rose for firms which had based their local operations on world class manufacturing methods that is to diffuse their knowledge and best practices across global actors. In particular, many firms have levered on lean manufacturing so as to develop high performance foreign subsidiaries and suppliers. In fact, lean manufacturing is widely recognized as a managerial method powerful in enhancing operational performance of a factory (Shah and Ward 2003; Liker 2004). Moreover, evidence exists of greater benefits obtainable when implementing lean in conjunction with supply chain partners (Womack and Jones 1996a; Hines and Rich 1997).

Although lean manufacturing has been successfully implemented worldwide, some previous studies have found that environmental differences between countries can affect lean implementation projects and their effectiveness (e.g., Hofer et al. 2011; Kull et al. 2014). For example, Kull et al.'s (2014) contribution showed that some socio-cultural values can hinder lean internationalisation, causing difficulties when adopting lean practices within a factory. In addition, economic conditions such as high turnover can affect the diffusion of internally related as well as externally related lean practices by causing loss of transferred knowledge, which can even threatening the sustainability of a project (e.g., Mefford and Bruun 1998; Wallace 2004; Hofer et al. 2011). According to Prasad and Tata (2003), it is crucial to provide a thorough understanding of the various socio-cultural, political-legal, economic, and educational factors that can affect internationalisation of best practices so as to define how effectively manage and take advantage of the unique conditions of each country.

A first important step towards integrating studies on internationalisation of lean manufacturing was done by Prasad and Tata (2003). However, they failed in providing a comprehensive view of the phenomenon since their focus was specifically directed towards a sub-bundle of lean practices (i.e., customer focus and satisfaction, strategic quality planning, human resource development and management, information and analysis, management of process quality). Other scholars adopting a broader perspective on practices (e.g., Wallace 2004; Hofer et al. 2011; Kull et al. 2014), instead considered only one or few dimensions describing international environmental conditions; to date most studies have focused on the impact of socio-cultural factors.

As a consequence, the literature is still lacking a holistic framework on the internationalisation of lean manufacturing, which helps to explain the influence of international environment differences between countries in determining main criticalities in lean implementation. This study attempts to fill this gap by discussing

two lean internationalisation projects successfully carried out by an Italian manufacturers: the first concerns diffusion of internally related lean practices to the Chinese peer subsidiary, the second the implementation of externally related lean practices in the Chinese supply base. In doing so, we take a broad view on factors describing the international environmental conditions, considering all the socio-cultural, political-legal, economic, and educational dimensions. Findings from the case study are compared with evidence from previous significant contributions on the internationalisation of lean (or sub-bundles of lean practices).

Although we also acknowledge the importance of organisational factors in affecting lean internationalisation projects, in the interests of parsimony our study focuses specifically on the impact of international environmental conditions. This is particularly important because, while several researches on lean manufacturing concentrated on organisational factors (see for example Rich and Bateman 2003; Achanga et al. 2006; Bortolotti et al. 2015a), literature on differences in environmental conditions is largely unexplored.

Our framework can be also of use to managers, as it helps to identify the main criticalities affecting the internationalisation of lean manufacturing as well as reasons behind them, thus helping to reduce lean projects' failures.

The remaining of the paper is organized as follows. In the next two sections we review studies on the internationalisation of the operations and of lean manufacturing, respectively. Then, a description of the methodology employed in the study is provided. Section 4 describes the background and presents an overview of the lean internationalisation projects. Section 5 discusses findings from the case study along with evidence from previous research. Finally, contributions and implications of the study are outlined in the conclusions, together with limitations and indications for future research.

2 Literature Review

2.1 Internationalisation of Supply Networks

Different aims can lead a manufacturer to internationalize its operations. For instance, Ferdows (1997) distinguished three main strategic reasons which can determine the location of a foreign factory: (1) access to low-cost production, (2) access to skills and knowledge of advanced suppliers, competitors, research laboratories, or customers, (3) or proximity to market. However, foreign direct investment is not the only alternative for a firm to develop an international supply network. Depending on the reasons that drive the internationalisation, it can be more appropriate to opt for exports, direct investments, or intermediate solutions such as equity or non-equity entry modes (e.g., joint ventures and franchise or license agreements, respectively) (Rugman et al. 1985; Douglas and Craig 1995). These are strategic decisions concerning the *configuration* of a manufacturer's supply network; however, it is also crucial to properly *coordinate* such network,

Table 1 Dimensions and factors describing the international environmental conditions

Dimension	Factors
Socio-cultural	Attitudes toward managers, perceptions of authority, inter-organisational cooperation, attitudes toward achievement and work, class structure and individual mobility, attitudes toward wealth and material gain, attitudes toward scientific management, attitudes toward risk, national ideology, beliefs about foreigners, and the nature and extent of nationalism. Cultural effects of customs, languages, attitudes, motivation, social institutions, status symbols, and religious beliefs have all been documented in the international business literature
	Societal cultures have been measured along a number of dimensions; two main models have been developed: (1) Hofstede's (1980) model, including individualism-collectivism, power distance, masculinity-femininity and uncertainty avoidance; (2) GLOBE model (House et al. 2004), including power distance, institutional collectivism, in-group collectivism, future orientation, performance orientation, gender egalitarianism, assertiveness, uncertainty avoidance, humane orientation
Political-legal	Defence/military policy, foreign policy, political stability, political organisation, flexibility of law, the role of government, labour organisations, local needs, industry standards, political ideology, political stability, relevant legal rules for foreign businesses, international treaty obligations, import-export restrictions, international investment restrictions, profit remission restrictions, and exchange control restrictions
Economic	Central banking systems and monetary policy, fiscal policy, economic stability, organisation of capital markets, market size and type, social overhead capital, exchange rate stability, market taste and demand, geographic dispersion, the quality of infrastructure, international trade patterns, membership and obligations in international financial obligations, international competition and international standards
Educational	Local literacy levels, specialized vocational training and education, higher education, and management programs

Source Adapted from Oliff et al. (1989) and Prasad and Tata (2003)

by defining how to effectively and efficiently share resources and diffuse knowledge between the dispersed factories (Porter 1986). This implies that firms make multiple and correlated decisions about the configuration (size, location, scope, and specialisation of the factories) and the coordination (degree of centralisation policies, incentives, measures, and controls) of a supply network (Hayes et al. 2005). This paper focuses on the diffusion of best practices (i.e., lean manufacturing practices) among actors of a manufacturing network; in fact, while scholars have extensively explored configuration, less attention has been devoted to coordination issues in general, and knowledge diffusion in particular, thus requiring further research (Pontrandolfo and Okogbaa 1999; Netland and Aspelund 2014).

It is widely recognized that best practice diffusion can help firms developing high performance networks, thus achieving a superior competitive advantage (Womack and Jones 1996a; Jensen and Szulanski 2004). However, several knowledge transfer projects have been characterized by problems and some even failed to attain such benefits (Jensen and Szulanski 2004). Differences in countries' conditions (e.g., socio-cultural characteristics) have been recognized to be a major

obstacle to best practice implementation among geographically-dispersed supply network partners (e.g., Kostova 1999; Jensen and Szulanski 2004; Kull et al. 2014). According to Oliff et al. (1989) and Prasad and Tata (2003), we consider four main dimensions in describing differences in the international environment: socio-cultural, political-legal, economic, and educational. Moreover, a number of factors are covered by each dimension; Table 1 summarizes main factors investigated by global operations management studies.

In addition, the difficulty of knowledge diffusion can also be influenced by the typology of best practices transferred (e.g., Teece et al. 1997; Kostova 1999; Maritan and Brush 2003). In particular, the diffusion of complex knowledge, such as lean manufacturing, it is likely to come across many criticalities (Maritan and Brush 2003).

2.2 Internationalisation of Lean Manufacturing

Lean manufacturing is a managerial method for eliminating waste from and continuously improving production processes within a factory, thus improving its operational performance (Womack and Jones 1996b; Shah and Ward 2003). Superior benefits can be achieved when individual efforts are linked up and down the value chain by cooperating with suppliers and customers, thus creating greater value for the final customer (Womack and Jones 1996a; Hines and Rich 1997; Shah and Ward 2007; Danese et al. 2012; Bortolotti et al. 2013).

Scholars have described lean method as a complex set of practices (Teece et al. 1997; Maritan and Brush 2003; Bortolotti and Romano 2012). According to Shah and Ward (2003), lean practices at factory-level can be grouped into four "bundles": just-in-time (JIT), total quality management (TQM), total preventive maintenance (TPM), and human resource management (HRM). By adopting a broader perspective, some previous studies have classified between internally related lean practices and externally related (or supply chain) lean practices (e.g., Shah and Ward 2007; Hofer et al. 2011). Setup time reduction, equipment layout for continuous flow, kanban, statistical process control, autonomous maintenance, small group problem solving, training employees, top management leadership for quality, and continuous improvement are the most important internally related lean practices, while JIT delivery by suppliers, supplier partnership, and customer involvement are among the main externally related lean practices (Shah and Ward 2007; Hofer et al. 2011; Bortolotti et al. 2015a, b).

Lean manufacturing originated from the production system of Toyota, a leading Japanese manufacturer in the automotive sector. For many years both the academics and practitioners have debated the transferability of lean practices outside Japan and the automotive industry. Although seminal books about JIT gave rise to the view of the Toyota production system (TPS) as a "Japanese thing", the success of the NUMMI's (New United Motor Manufacturing) experience—the joint venture between Toyota and the American General Motors—was a first main

evidence of its transferability to the Western world (Holweg 2007). The book *The Machine that Changed the World*, which also coined the term "lean manufacturing", strongly contributed in straitening and diffusing the idea of the "universality" of lean method (Womack et al. 1990). Several successful cases of lean firms in different countries and of various industries have followed, thus further proofing this second stance (Hines et al. 2011; Shah and Ward 2007).

However, as studies on NUMMI and other cases of lean internationalisation showed, successful implementation of lean depends on some organisational conditions such as the presence of a lean culture within a factory, the wide implementation of the various lean practices, and the existence of cooperative relations with customers and suppliers (e.g., Dyer and Nobeoka 2000; Shook 2010; Bortolotti et al. 2015a). For example, Bortolotti et al. (2015a) found that successful lean factories distinguish from manufacturing units that implement lean obtaining lower operational performance in terms of a lower assertiveness.

The environmental conditions of a country can favour or hinder lean implementation. For example, countries such as India, Malaysia, or Thailand are characterized by a high score on assertiveness (House et al. 2004); such incongruence between socio- and ideal lean cultural values is likely to make lean implementation more difficult (Wincel and Kull 2013). Similarly, also political-legal, economic, and educational conditions can influence lean implementation and its effectiveness (Mefford and Bruun 1998; Prasad and Tata 2003). In order to successfully internationalise lean manufacturing, it is thus fundamental to understand how factors describing the international environmental conditions affect lean implementation. Although a number of studies have focused on such phenomenon, they provided a partial perspective and literature is still missing a holistic framework on the internationalisation of lean manufacturing. In the attempt to enhance the understanding of such topic, our study provides a broader perspective, considering the impact of all the four dimensions describing international environmental conditions on the implementation of internally as well as externally related lean practices.

3 Methodology

In order to explain how international environment differences, in terms of sociocultural, political-legal, economic, and educational environmental conditions, influence the internationalisation of lean implementation by determining criticalities in the implementation of internally related as well as externally related lean practices, an empirical research based on a single case study was designed. In fact, this methodology allows to provide an in-depth description of the phenomenon under examination (Yin 1994; Voss et al. 2002).

Theoretical sampling approach guided the selection of the case study (Eisenhardt 1989). First of all, we chose a case in which the phenomenon under

Table 2 Overview of the case

Firm's general information	Factory which designed and implemented lean internationalisation projects	Recipient non-lean factories	
		Project 1—Chinese subsidiary	Project 2—Chinese suppliers
The firm including nine manufacturing units in three continents (Asia, North America, and Europe) Headquarters in France Products range: critical power, power control and safety, energy efficiency, and solar power solutions	Italian factory It produces products and services relate to high-availability power supplies to critical applications for the European market	Subsidiary located in Shanghai (China) About 40 employees—mainly local—work in the factory It provides products and services relate to high-availability power supplies to critical applications for the Chinese market	Factories located in China (the majority in Shanghai) Typically more than 100 employees—mainly local—work in each factory It provides various sub-systems and materials

study was "transparently observable" (Pettigrew 1988); longstanding collaboration between the firm and researchers was crucial for assuring access to sensitive data. Second, we selected a firm which had recently launched lean internationalisation projects towards a foreign subsidiary as well as foreign suppliers so as to provide evidence of problems in diffusing internally related as well as externally related lean practices. Moreover, we verified that the factory which had designed and implemented lean internationalisation projects had a high competence in the lean method and that the lean internationalisation projects were successful (i.e., lean practices persisted in the recipient factories over time), while the foreign subsidiary and suppliers were non-lean factories at the beginning of the lean knowledge transfer project. This process resulted in the selection of an Italian factory excellent in lean that transferred lean towards the Chinese non-lean subsidiary and its supplier base (see Table 2 for further details). To preserve confidentiality, we did not disclose the name of the firm.

As suggested by Yin (1994), we created a case study research protocol before embarking upon the research so as to enhance the reliability and validity of the case. This protocol guided the overall study design and execution. It comprised six main sections descended from the literature on the internationalisation of supply network and lean manufacturing. These sections are: (1) socio-cultural differences, (2) political-legal differences, (3) economic differences, (4) educational differences, (5) problems in the implementation of internally related lean practices, and (6) criticalities in the implementation of externally related lean practices. For each section the protocol listed some issues to be examined, thus assuring the researchers to gather complete and useful data on the lean internationalisation projects. In particular, this research protocol guided a series of semi-structured interviews.

Managers in charge of every lean internationalisation project and their close collaborators were interviewed in the period between March 2013 and November 2014. Both the researchers participated at all the interviews, which ranged from 90 to 160 min. We recorded and painstakingly transcribed each interview. In addition, we analyzed firm's documents (e.g., firm's internal documents on lean internationalisation projects, handbook of lean practices, documents on KPIs trends, etc.). Finally, we also participated to guided-tours of the Italian factory and two main suppliers which allowed direct observations of internally related and externally related lean practices used by the firm. As suggested by several scholars (e.g., Eisenhardt 1989; McCutcheon and Meredith 1993), in order to increase research reliability we triangulated information from interviews with those in firm's documents and collected through other methods.

Data analysis relied on an iterative approach, which involved frequent steps back and forth among the data. This is also a result of frequent discussions of preliminary analysis among the researchers and managers involved in the lean internationalisation projects.

4 Background and Overview of the Lean Internationalisation Projects

In 2005 the Italian factory started the implementation of internally related lean practices, while first lean initiatives with local suppliers—i.e., the adoption of externally related lean practices—were launched a year later. The joint effort in implementing lean method allowed to significantly improve the quality of the products, which was crucial to guarantee no damages to customers' production machineries. Moreover, it led to reduce costs of manufacturing as well as to enhance delivery performance. Considering these important improvements, the headquarters made the Italian factory responsible for developing a new subsidiary in China and its supply based according to lean method.

First, a lean internationalisation project was launched in late 2008, when was established the new Chinese subsidiary. After various weeks of training in the Italian factory (only for key foreign managers), some Italian lean managers moved to China to support training activities and production start-up. Since this overseas factory would have provided products and services specifically for the Chinese market, it was necessary to involve Chinese suppliers to create highly valuable solutions for foreign customers. Therefore, a second project was launched in late 2009 to create a lean supply base in collaboration between Italian and Chinese lean managers.

Several problems occurred during both the projects, which can be linked to the environment conditions. Table 3 illustrates some of the major problems encountered during the implementation of internally related as well externally related lean practices. Next section discusses these problems with respect to socio-cultural, political-legal, economic, and educational environmental conditions.

Table 3 Main problems occurred during the internationalisation of lean manufacturing

Sub-bundles of lean practices	Problems
Internally related practices	Lack of self-initiative, little participation to improvement and problem-solving initiatives, difficulties in providing suggestions (e.g., how to improve an activity) or even simpler information (e.g., whether they feel safe or are satisfy about work conditions, elucidations of lean standards during training, etc.); problems in the start-up of the foreign subsidiary such as in importing machineries and materials from Italy, selecting qualified employees, defining effective incentives; slowdowns in lean activities and stop of some improvement actions, precluding continuous improvement and resulting in declines in the subsidiary's productivity; need for several adaptations, such as for tools, work instructions, suggestion systems, and KPIs boards, towards more visual solutions; need for easier solutions when implementing lean practices, such as fewer operations for each work station, less automation, stock division to make flow of materials more visible, etc.; communication problems and misunderstandings
Externally related practices	Sub-systems which not met Italian factory's quality requirements and/or the planned delivery time; problems in Chinese supplier involvement in quality improvement programs; problems in exporting some products made only by the Chinese subsidiary to Europe; difficulties in involving customers and suppliers in joint improvement initiatives; difficulties in developing close relations with customers and suppliers; difficulties in implementing JIT (e.g., high cost, need for controlling inflow materials, etc.); problems in communications with suppliers; difficulties with making suppliers accept high levels of standard quality; defective sub-systems sent back several times

5 The Influence of Environment Conditions on Lean Manufacturing Internationalisation

As shown in Table 2, several problems affected the lean internationalisation projects launched by the Italian factory towards China. With regard to the internally related lean practices, some criticalities, such as lack of self-initiative and little participation, are likely to be explained by socio-cultural differences between the countries. For example, the high power distance seems to be a prominent cause of the little participation of Chinese workers in learning sessions as well as in team-based improvement initiatives. An Italian manager involved in the lean internationalisation project towards the Chinese subsidiary reported:

> We have struggled with making them participating in improvement activities. Operators used to wait for supervisors' orders, thus had difficulties in providing suggestions on how to improve activities or solve problems. They were worried about providing even the simplest information, such as if they have encountered problems in performing a particular job. […] During learning session they've never asked for clarifications.

Coherent with our findings, some previous studies on the internationalisation of lean manufacturing have shown that the lack of self-initiative and little participation are common attitudes of Chinese workers that reflect Hofstede's (1980) cultural value of high power distance, which have generally hindered the implementation of internally related lean practices (e.g., Aoki 2008; Chen and Bo 2008; Paolini et al. 2005; Hofer et al. 2011). In particular, high power distance was found to impede the involvement of employees—especially of operators at lower level of the organisation—in training, suggestion and improvement programs and problem solving teams (Aoki 2008; Hofer et al. 2011). Mefford and Bruun (1998) explained that paternalistic relations between managers and employees are a cultural obstacle to lean that is common to various developing countries. For example, Kenney and Florida (1994) have indicated the lack of responsibility-taking and active participation of the workforce as a barrier in lean implementation in the Maquilas (Mexico).

More recently, Kull and his research team have taken a global perspective in exploring the role of national culture in determining the effectiveness of internally related lean practices (see Wincel and Kull 2013; Kull et al. 2014). Their analysis conducted on the Global Manufacturing Research Group dataset—which includes 1453 facilities from twenty-four countries and twenty-two industries—showed that the GLOBE culture dimensions of future orientation, performance orientation, and assertiveness have a negative effect on lean implementation effectiveness. Basing on these results, they suggested to rank countries from ones that tend to be "the most hospitable" to lean to those where lean is likely to be more difficult to implement. They concluded that (Wincel and Kull 2013, p. 104): "Many of the Western industrialized nations, including the United Stated, demonstrated a relatively low level of lean effectiveness. Many Eastern European and Asian-Pacific nations showed the highest effectiveness. It can be interpreted from the data that countries like Croatia, Korea, Albania, Macedonia, and Taiwan have country cultures that are more aligned with the key underlying lean values than countries such as New Zealand, Italy, Canada, and the Unites States."

Socio-cultural differences are likely to explain also various criticalities in the implementation of externally related lean practices. Our observations show that there were supply problems for some sub-systems which not met Italian factory's quality requirements and/or the planned delivery time. As Italian managers explained, these problems occurred because Chinese suppliers paid no grate attention to performance requirements; in turn this attitude is likely to be a reflection of the low level of performance orientation of the Chinese country (House et al. 2004; Naor et al. 2010). In addition, as for internally related lean practices, the high power distance is likely to explain observed problems in Chinese supplier involvement in quality improvement programs:

> We had also problems in making suppliers participating in improvement activities. As for Chinese subsidiary's employees, suppliers had difficulties in providing suggestions and feared in giving also simple information.

These findings are in line with some previous studies analyzing the impact of national culture on externally related lean practices. For example, Zhao et al. (2006) indicated China's unique cultural characteristics as a leading reason to challenging collaborations with supply chain partners. Similarly, Dyer and Nobeoka (2000) observed that Toyota initially had difficulties when interacting with suppliers of the factory in Georgetown (Kentucky) because of the low inter-organisational cooperation, which was typical among supply chain counterparts in the US.

Second, the analysis of the lean internationalisation projects launched by the Italian firm towards China suggests that some of criticalities affecting the implementation of internally related as well as externally related lean practices can be traced to political-legal conditions. For example, the Italian managers reported problems in the start-up of the foreign subsidiary due to the presence of differences in rule setting and enforcement between various areas of China:

> We found a lot of difficulties during the initial phases of the [lean internationalisation] project. We had to learn rules concerning the introduction of the material… we initially imported everything – machineries, materials, etc. – from Italy; but some things were not allowed, thus needing changes. We didn't know how to find right workers and which incentive systems were more effective to promote lean implementation in China. […] Differences between the Italian and Chinese rules were the first obstacle; differences in rule setting and enforcement between areas were a further challenge. For example, districts in Shanghai are more expensive, and then you need to pay a higher salary to retain workers.

In line with these findings, Shie (2004) observed that in China most regulations are mere guidelines and do not represent formal laws; in addition, marked rivalries between areas (e.g., provinces, towns, and local administrative districts) contribute in determining differences in rule setting and enforcement (Handfield and McCormack 2005), which can hinder lean implementation projects (Hofer et al. 2011). Some scholars also found that the Government can negatively influence lean practices concerning people management and training programs (Dian-Xiang and Willborn 1990; Ehrenberg and Stupak 1994). This is also the case of China, where programs can not be in contrast with "the policies of the Government" (Dian-Xiang and Willborn 1990). According to some authors (e.g., Cole and Deskins 1989; Kenney and Florida 1995; Liker and Meier 2006), labour unions such as those present in the U.S. or in other developed country can also hamper lean practice implementation, and in particular cross-training and teamwork.

As for internally related lean practices, political-legal characteristics of a country can also hinder supply chain lean practices. Our observations suggest that, for example, the Italian firm has encountered problems with some products made only by the Chinese subsidiary but sold also to European customers. Such products included a sub-system that was produced by Chinese suppliers in accordance with Chinese certification's requirements; unfortunately, such requirements were less demanding then ones essential for the commercialisation and use in the European Union.

The literature provides other examples of a negative impact of political-legal conditions of a country on externally related lean practice implementation. For example, Forker (1990) observed that quality levels remained stagnant in countries

characterized by closed market—e.g., the former Soviet Union. Jayaram et al. (2010) analyzed 2000 manufacturing firms in 48 states in the U.S. and Puerto Rico and found that there were significant differences between unionized versus non-unionized factories in the approach and effectiveness to managing supplier quality efforts.

Third, economic differences between the countries were also found to hinder the internationalisation of lean manufacturing. From the analysis of the case study it emerges that the high employee turnover was a major cause of problems in the implementation of internally related lean practices in the Chinese subsidiary. Dismissal of several operators and of the operations manager caused repeated slowdowns in lean activities, which resulted in declines in the subsidiary's productivity. An Italian manager observed:

> The high employee turnover is a main criticality of China; it put a strain on the sustainability of the lean project. Much time had to be spent for training new and new employees [i.e., workers who replaced dismissed ones] on lean working method. Instead of focusing in enhancing lean knowledge of more experienced operators, we needed them to train new operators. […] [After operations manager dismissal,] some improvement initiatives needed to be momentarily stopped, thus precluding continuous improvement.

Several previous studies in the literature pointed to economic conditions of a country in general, and high turnover rate in particular, as a barrier to lean implementation. Many authors indicated high employee turnover as a main impediment to employee involvement in China (e.g., Taj 2005; Aoki 2008; Hofer et al. 2011). Similarly, other scholars observed that high turnover rate also hindered lean implementation in other developing countries, such as Brazil (e.g., Humphrey 1995; Wallace 2004) and Mexico (Kenney and Florida 1994; Mefford and Bruun 1998).

Economic conditions can also hider the implementation of externally related lean practices. The Italian managers reported a number of criticalities in lean initiatives involving supply chain partners linked to economic conditions. In particular, the high employee turnover characterizing both suppliers' and customers' factories has been an obstacle for their involvement in joint improvement initiatives as well as for the development of close relations. In addition, the great distance from qualified suppliers together with poor conditions of infrastructure hindered the implementation of JIT. In fact, frequent deliveries were too expensive, and the need of controlling the qualities of supplied materials precluded the creation of a pull system with suppliers.

Some scholars dealing with the internationalisation of lean manufacturing provided similar findings. For example, Lawrence and Lewis (1993) indicated high employee turnover as a major economic factor hindering inter-organisational relationship development in China. In addition, Yavas and Burrows (1994) and Paolini et al. (2005) observed that the geographic distances combine with poor infrastructures seemed to affect quality problems in China and other Asiatic countries. They explained that, for example, poor road conditions can cause traffic jams, breakdowns of delivery vehicles or extensive vibrations during transport, which in turn

are likely to affect delivery and quality performance. These findings are also consistent with observation of Mefford and Bruun (1998), which indicated poor infrastructure among the main obstacle for JIT implementation in Mexico.

Finally, lean internationalisation project effectiveness can vary according to educational differences between the countries. Our case study shows that educational conditions in China hindered the implementation of internally related practice. For example, low literacy rate required several adaptations of tools, such as work instructions, suggestion systems, and KPIs boards, towards more visual solutions. Local managers were not proficient in the English language, while operators only spoke local language; this hindered the transfer of lean knowledge and forced the Italian managers to opt for easier solutions when implementing lean practices (e.g., fewer operations for each work station, less automation, stock division to make flows of materials more visible, etc.).

In a similar vein, Prasad and Tata (2003) argued that basic education is crucial for the success of training in quality management practices. In particular, a lack of training in statistical tools is among the main causes of the lag on quality management practice implementation in China respect to Western countries (Rao et al. 1999; Zhao et al. 2006). In contrast, higher levels of mathematical education in developed counties such as former communist countries led to faster implementation of quality management practices (Lee et al. 1992; Young 1992). Lack of knowledge and poor education level among shop floor workers were also mentioned as obstacle to lean implementation in other developing countries, such as Brazil (Humphrey 1995; Wallace 2004), Mexico (Kenney and Florida 1994; Mefford and Bruun 1998) and India (Dhandapani et al. 2004; Seth and Tripathi 2005). In particular, Seth and Tripathi (2005) observed that low education reflected in a common view of maintenance as expenditure and not as an investment in India.

Educational differences can also affect the implementation of externally related lean practices. In our case study the Italian managers reported problems in communication with suppliers due to poor language skills (as in case of employees in the Chinese subsidiary, suppliers were not proficient in the English language). In addition, different meanings attributed to words such as “quality” concept led to supply problems; for instance, materials not always met the requirements specified by the Italian factory.

> Our products are critical for the production activities of our customers. We can’t sell a defective product – also if the defect is little –, then risk a failure that can damage customers’ machineries. Also suppliers must respect the same quality standards. […] At first there were several problems with Chinese suppliers; we sent back defective sub-systems several times. They have had difficulties with accepting such high levels of quality. It was not easy to explain them our quality standards.

Similarly to internally related lean practices, factors such as lack of training and education can also hider the implementation of JIT or the development of quality improvement programs with suppliers. For example, Ismail Salaheldin (2005) found that among the main problems in implementation JIT in Egyptian manufacturing firms there was a lack of formal training/education for suppliers.

Based on the findings from our case study and evidence from the literature, it appears that the the socio-cultural, political-legal, economic, and educational differences in the international environment can influence the implementation of internally related as well as externally related lean practices. Hence, we propose the following proposition which summarizes the general relation between the environmental conditions and lean practice implementation:

Proposition *International environmental conditions will influence the implementation of lean manufacturing*.

6 Conclusions

Many firms which had significantly improved operational performance of the headquarters and local factories through lean implementation have recently launched lean internationalisation projects so as to extend such benefits to foreign subsidiaries and/or suppliers. In fact, lean is almost unanimously recognized as a "universal method", i.e., a method effective in eliminating waste from and continuously improving production as well as supply processes of factories located worldwide (Womack and Jones 1996b; Shah and Ward 2007). Nevertheless, environmental differences between countries can affect lean implementation projects, causing difficulties when adopting lean practices in foreign factories, which can even threatening the success and sustainability of lean internationalisation projects.

This research contributes to the literature by enhancing the understanding of the impact of international environmental conditions on lean internationalisation projects. Previous studies failed in providing a comprehensive view of the phenomenon since they focused on sub-bundle of lean practices and/or only one or few international environmental conditions. Instead, our study based on a holistic framework which involves socio-cultural, political-legal, economic, and educational environmental dimensions, and internally related as well as externally related lean practices. Findings from the case study were compared with evidence from previous significant contributions on the internationalisation of lean (or sub-bundles of lean practices), providing a description of main criticalities affecting the internationalisation of lean manufacturing towards different countries and shedding light on reasons behind them. These results can also guide practitioners in anticipating adaptations and countermeasure definition, thus helping to reduce lean projects' failures.

In concluding on our results, it is important to keep in mind the limitations of the study which can be the basis for interesting future research. In particular, the use of a single case study limits the generalisability of the conclusions. Future multiple cases can be conducted so as to augment external validity. Moreover, the selection of cases belonging to similar versus different environments can be useful so as to outline a taxonomy of main problems affecting lean internationalisation

projects. For example, we observed that some contextual conditions are common between developing nations, but different to ones characterizing developed countries (e.g., high power distance/paternalistic relations between managers and employees or high turnover rate in China, Mexico, Brazil, etc. versus well-established labour unions in U.S. and other developed nations); this reflects on the presence of similar problems within a type of nation, and different criticalities between developing and developed countries (e.g., lack of self-initiative and low participation to problem solving activities versus difficulties in effectively applying cross-training). Classifying problems between macro-areas—such developing and developed countries—can be useful for supporting practitioners in countermeasure definition, by helping them in defining solutions effective in various countries.

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