Proceedings Paper:
Tong, Z and Huaccho Huatuco, L (2018) Lean manufacturing, culture and their role on sustainability: A case study in the Chinese automotive industry. In: Dao, D, Howlett, RJ, Setchi, R and Vlacic, L, (eds.) Sustainable Design and Manufacturing 2018 (SIST, volume 130). 5th International Conference on Sustainable Design and Manufacturing (KES-SDM 2018), 24-26 Jun 2018, Gold Coast, Australia. Springer , pp. 1-10. ISBN 9783030042899

https://doi.org/10.1007/978-3-030-04290-5_1

Lean manufacturing, culture and their role on sustainability: A case study in the Chinese automotive industry

Zhe Tong[1] and Luisa Huaccho Huatuco[1]*

[1] The York Management School, University of York, UK, YO10 5GD

*corresponding author: Luisa.huatuco@york.ac.uk

Abstract. This paper focuses on lean manufacturing and culture and how they influence the sustainability initiatives of an Automotive company in China. The principle of lean manufacturing is widely applied in the automotive industry worldwide. The last few decades have witnessed the accelerating pace of China's continued emergence as a major industrial power. With the globalisation of multinational corporations and the development of domestic automotive enterprises, there is an increasing number of cross-cultural motor manufacturing companies starting their business in China. In these companies, cultural diversity is an important factor that affects the management strategies. Using a case study approach, this paper shows the relevant themes on the role of lean manufacturing and culture on the sustainability initiatives taken by the company.

Keywords: Lean manufacturing, Culture, Sustainability, Automotive, China.

1 Introduction

China has emerged as a World manufacturing super power in the last few decades. This has brought sustainability concerns, especially in relation to controlling pollution in the air. This paper focuses on Company X, a Chinese-French joint venture that dominates in the emissions control (as part of their sustainability efforts), vehicle interiors and seating fields. Company X's Wuhan branch in China is the case study company in this paper. As a cross-cultural company, it is a typical example about the impact of cultural difference on lean manufacturing's application, and as a leading motor manufacturing company, it has high-possibility to conduct lean manufacturing to a further extent. A qualitative research method was used to interview relevant employees then a thematic coding method was used to analyze the data.

The research questions addressed in this paper are: 1) What are the philosophy problems in lean manufacturing theory?, 2) What lean manufacturing tools have been mainly used in automotive industry?, 3) Do cultural differences between China and France cause the implementation of different lean management strategies?

The paper is organized as follows. Section 2 presents the literature review on lean manufacturing in China and Hosftede's model and organizational management. Sec-

tion 3 shows the case study methodology. Section 4 provides the results of the qualitative analyses. Section 5 discusses the findings and compares to wider literature. Section 6 draws conclusions as well as limitations, implications for theory and practice, and identifies avenues for future research.

2 Literature Review

2.1 Lean manufacturing in China

The lean manufacturing concept is also adopted by a large amount of Chinese culture-based automotive manufacturing firms. The pioneer who brought Toyota production system to China was First Automotive Works (FAW), the Chinese motor firm which was the representative of Ford Production System in China, and in the late half of the 1970s, with the help from the originator of lean manufacturing, Taiichi Ohno, lean manufacturing began to play its role in China [6]. According to [7], there are some reasons can be used to explain why lean manufacturing became popular in China. One of them is applying lean manufacturing, which can help organizations build a high reputation as it can be regarded as willing to accept new concepts and techniques. Some of these are: Just-in-Time (which aims to eliminate the 7 types of waste: over-production", "waiting", "transport", "extra processing" "inventory", "motion" and "defects"), 5S (as "sort", "set in order", "shine", "standardize" and "sustain"), Value Stream Mapping (VSM). Previous empirical research found that some companies achieved positive performance from lean manufacturing. For instance, the work-in-process (WIP) of FAW was reduced by 70% after the adoption of TPS [7]. Shanghai-VW, the joint venture enterprise that combined by Shanghai Automotive Industry Corporation (SAIC) and Volkswagen (VW) acquired the remarkable achievement since it applied TPS in the 1990s [27], and until now, this concept also plays the role as guidance for Shanghai-VW.

2.2 Hofstede's model and organizational management

[23] compared and discussed the cultural distance between China and Western countries using the Hofstede's Model, and the results showed that China has high power distance, high uncertainty avoidance and long-term oriented country that tends to collectivism and medium femininity [24], while most of the Western countries have different cultural characteristics. [18] illustrated the impact of Hofstede's cultural differences theory on organizational management in detail from the following aspects:

1. Impact of "Power distance" and "Uncertainty avoidance" on decision making,
2. Impact of "Individualism and collectivism", "Masculinity and femininity" and "long-term orientation and short-term orientation" on cooperative management, and motivation systems,
3. Social and interpersonal relationship ("guanxi" and "face") are the important components in Chinese culture.

During the investigation of the Toyota Production System (TPS) in the Chinese automotive industry, cultural differences will be considered to illustrate how Company X's managers deal with the differences in the application of lean manufacturing.

3 Research methodology

Thematic analysis is a qualitative descriptive method to describe the important phenomenon through "careful reading and re-reading of the data" ([12], p. 258). There are five major steps: collecting data, setting initial codes, searching for themes & categories, reviewing & adjusting initial themes & categories and producing the final results ([2]; [5]; [30]; [13]). [30] provided a description about the first step, which means gathering information through transcribing interviewee's answers.

However, in this research, there is another stage in collecting data, which is translation from Chinese into English after transcription as the interviewees are Chinese. The second step is producing the initial codes. Codes can refer to both "manifest content of the data, that is, something directly observable" and the implicit meanings hidden behind the messages ([12]; [4]). [5] pinpointed that codes can be broadly divided into two categories, which are data-driven codes (inductive coding) and theory-driven codes (deductive coding). [4] stated that data-driven codes represent an inductive approach that means the ideas are recognized from the raw information pool. In this research, it means the important and meaningful points which are extracted from the interviews through highlighting the multi-referred words in the content.

Moreover, existing codes to produce the appropriate themes (patterns) and categories were used. [2] described this process as identifying different codes to different themes. Themes derive from interviewees' answers and emerge through gathering the useful and relevant codes to compose the uniform ideas, following by subdividing them into different categories ([19]; [8]). [28] mentioned that there are various types of themes such as "conversation topics, vocabulary, recurring activities, meanings, feelings, or folk sayings and proverbs" (p.131). When building categories (sub-themes) to obtain a comprehensive understanding of the dataset, the analyst will usually select the aspects that are repeated mostly by the majority of the interviewees and display them using specific words or sentences. The following step is the process of reviewing and adjusting the established themes and categories. [11] asserts that this step should be operated after reading and assessing the third step for several times.

In this research, the data are collected from the semi-structured interviews from three managers and two employees at Company X, who were selected for their knowledge and practical expertise on the topic of this study, which can ensure validity. When the interviews were transcribed and translated, it was found that there were some answers out of topic, which could not be tied up to the research questions perfectly. So, the relevant participants (namely the managers) were contacted again to obtain a more accurate response, which provided a reasonable opportunity to review and adjust themes and set more precise sub-themes. After checking the reliability of the last step, the final results can be produced effectively.

According to [9], [31] and [33], a case study aims at producing a comprehensive understanding about a question that is based on real-life experience. When conducting interviews, a semi-structured method to collect information was used. Semi-structured provided interviewers with a more flexible approach to communicate with interviewees to obtain more valuable information. Specifically, this method allows interviewees some degree of flexibility to talk about what they want [10] and provide interviewers some opportunities to alter prepared questions to align with the topic [12]. 15 questions were designed and applied covering the following issues at Company X: lean implementation, culture, sustainability, 5S, VSM and performance. In this interview process, Wechat's free video call was used. For the list of interviewees, see Table 1.

Table 1. Information about participants

Interviewee	Gender	Age	Job title	Years of experience in Company X	Duration of interview
1	Female	45	Financial Manager	25 years	30 minutes
2	Female	39	Deputy Financial Manager	15 years	20 minutes
3	Male	52	Production Manager	20 years	30 minutes
4	Male	28	Worker	5 years	15 minutes
5	Male	30	Worker	8 years	15 minutes

4 Results

After transcribing and translating interviews to collect data, the next step is deducing the explicit codes and implicit codes that interviewees mentioned according to the existing theories. From the concept from [12], the specific process of deductive coding is reading other people's research to set the initial codes, using these pre-decided codes as the standard to attach the interview and to count how many times the codes occur. The research can also analyze the relationship between different codes, in terms of "occurrence or sequencing" [13]. For example, an analyst may decide the initial code as "challenge" and desire to know how many interviewees mentioned this code in the entire interview, and then the analyst may want to realize whether the mention of "challenge" was typically followed by talking about of "difficulty".

Having read and re-read the entire corpus of the data, one needs to create a conceptual tool with which to classify, understanding and examining the collected data. Thus, the researcher devises a coding book (coding frame or coding book) to guide the thematic analysis. It contains the full set of codes that one chooses to apply to the

dataset [13]. Thus, in devising a coding frame for the application of lean manufacturing in Company X, the researchers found the relevant theory-driven codes in reports, journals, dissertation and other types of documents and an inductive reading of the full set of interviews. The initial codes are listed below:

A) Integrate lean production principle into staff management
a) Emphasis on manager's contribution
1. Propaganda and training
b) Employees should cultivate self-discipline
1.Stress the responsibilities of employees
2. Establish reasonable control and motivation system
c) Insist on continuous improvement
1. Improve production operation system
2. Improve process quality
3. Continuous improvement requires correct method
B) The application of lean production
a) JIT is the most widely used management concept
b) 5S is the foundation of other management methods

Table 2 shows a sample of the coding frame.

Table 2. Sample codes used in analysis

Code	Definition	Example
Culture	It is significant that the adaptation of Japanese-based lean manufacturing in China should integrate Chinese culture and Chinese automotive industry environment into it.	*"For a large number of* relative low-level Chinese motor manufacturing enterprises, it is very important for them to realize that the implementation of lean production must be combined with national conditions and actual *industry situation."* (Interviewee 2)
Waste reduction	The nature of company is profit maximization by reducing waste	*"*In order to make a profit in the price competition, we must try our best to reduce costs and waste*"* (Interviewee 3)
Sustainability-friendly	Company X as the leading motor manufacturing company, aims at developing sustainable-friendly by applying new technology	*"And it also focuses on the development of* renewable sources, biological materials to *create a lighter car"* (Interviewee 3)
Training	Training employees to cultivate comprehensive talents	*"*We have multi-skill training and management system so that employees can learn more job skills to become comprehensive talents *rather than unilateral experts"* (Interviewee 1)

When using thematic analysis to investigate the application of lean manufacturing in Company X, the word that was mentioned most by interviewees is "culture", which

means it is significant that the adaptation of Japanese-based lean manufacturing in China should integrate Chinese culture and Chinese automotive industry environment into it. In summary, through the reviewing and adjusting process, the final version of themes and categories were produced (See Table 3).

Table 3. Final version of themes

Theme	Category	Description
1		Integrate lean manufacturing principle into staff management
	1	Emphasize on manager's contribution
	2	Employees should cultivate self-discipline
	3	Insist on continuous improvement
2		The application of lean manufacturing
	1	JIT is the most widely used management concept
	2	5S is the foundation of other management methods
3		Culture plays a vital role in Chinese-based lean manufacturing
	1	National culture guides management strategies
	2	Industrial culture requires profit maximization and cost minimization
	3	Enterprise culture focuses on sustainable development

5 Discussion

5.1 Continuous improvements can be achieved by self-discipline

Regarding, the first research question on: What are the philosophy problems in lean manufacturing theory? it was found that Company X can tackle effective measures to improve employees' self-discipline and self-control to achieve continuous improvement. According to [3], continuous improvements' operation requires relevant standards, including an instruction about the specific improvement measures to guide employees and a system to control and motivate employees to follow the instruction. From the interviews, it was found that these standards are conducted in Company X. Integrating the interviewees' answers, it can be concluded that a perfect and valuable improvement measures instruction should set from the angle of primary-level workers as they can proceed from their actual conditions and propose effective suggestions. Moreover, a feasible control and motivation system should aim at groups' performance rather than individual, which cannot only improve employees' responsibilities to conduct improvements consciously, but also provide managers an intuitive impres-

sion about how these improvements could take place. Furthermore, the implementation of continuous improvements does not only develop employees' self-discipline and self-control but also trains their ability to solve various problems. [20] emphasized the significance of comprehensive training, which was witnessed by Company X's pre-job training and rotation systems. Therefore, when problems occur, those all-talented workers can solve them timely and due to their self-discipline, the quality of products can be strictly controlled, which lays a foundation for improving production efficiency and yielding economic benefits.

5.2 JIT and 5S are the most widely used lean manufacturing tools

Regarding the second research question on: What lean manufacturing tools have been mainly used in automotive industry? From the literature review, it can be found that the three typical tools/concepts are: JIT, 5S, and VSM. However, from the interviews, VSM was not mentioned by any participant. Whichever the tool is, reduction of waste is always the main purpose. In section 2, the seven major types of waste were identified, for instance, [16] mentioned that reducing inventory is the most basic for the application of lean manufacturing; [1] stated transport waste will cause non-valued cost to the end-customers; [15] provided an opinion that defects reduction can be linked with continuous improvements and self-discipline.

Firstly, in lean manufacturing, the production plan is determined and pulled by consumers' demand rather than derived from intra-company requirements, the department's managers will not set production plan until they receive an order, therefore it can ensure the company's inventory is reduced not increased. Secondly, Company X built several factories and warehouses in transportation junctions, which can reduce cost and shorten transportation time. Thirdly, the production process is guided by SOP (Standard Operating Procedure), which contains six elements: where to use this work instruction? what kind of people should use it? what is the name and content of this work? what is the purpose? when should we do it? and how to complete the operation step by step?. Using it as a guidance for production can ensure products are in line with the specifications, which will reduce the number of defective products.

5.3 Cultural differences can benefit management strategies

The last research question is: Do cultural differences between China and France cause the implementation of different lean management strategies? Through systematic analysis, it was found that cultural diversity in the cross-culture company leads to positive management strategies, which provides Company X an opportunity to achieve good performance. The following discussion will be conducted from national culture, industry culture, and enterprise culture on these three aspects. Firstly, based on Hofstede's cultural theory, the cultural diversity will lead to different operational modes and strategies [22]. [32] stated that the effect of national culture will reflect in the organization from several aspects. In Chinese culture, collectivism, femininity, high power distance, and high uncertainty avoidance are the main characteristics, which leads to the Chinese managers emphasise: cooperation, loyalty, power concen-

tration and making decisions by themselves. In the Western culture, the main characteristics are: individualism, masculinity, low power distance, and low uncertainty avoidance, and these mean that top managers prefer to decentralise their rights and cultivate employees' sense of individualism. For example, Company X's appraisal system is based on group work rather than individual performance, which means the whole group will be regarded as a whole for obtaining rewards or receiving punishments. Moreover, Company X focuses on giving more opportunities for employees to participate in the decision-making to provide the most effective continuous improvement measures based on their real experiences. Secondly, in the Chinese automotive industry, the central government plays a very important role. Since the 1980s, the auto industry had become the main target for the central government to control through formulating strict policy [26]. [25] and [29] proposed that one obvious objective the local government sets for Chinese auto industry companies is profit maximization, which means increasing local fiscal revenue. Based on this objective, the Chinese motor companies contribute to decreasing waste and cost to the minimum during production, which adheres the principle of lean manufacturing perfectly. Thirdly, it is undeniable that in the last decade, motor vehicles had become the largest source of urban air pollution in China, the reasons caused this situation is that China does not only have the adequate emission-control policies but also does not have the cutting-edge technology to support the exhausts purification [14]. In order to address this problem, the relevant Chinese institutions encourage motor manufacturing companies to develop the sustainable and green products. Company X is the leading company in automotive manufacturing in China, regarding sustainability efforts to promote technological advancement to achieve sustainable development. Specifically, it not only develops emission control systems to reduce pollution of exhaust emissions, but also upgrades noise-dissipation systems to reduce noise pollution.

6 Conclusions

It could be argued that lean manufacturing and culture play an important role in the sustainability efforts of Company X. There are seven key findings in this paper: 1) it is important for companies to train qualified personnel, 2) companies can cultivate employees' self-discipline by building effective control and motivation systems, 3) continuous improvement measures should integrate employees' opinions, 4) the aim of JIT is zero inventory that can be achieved by choosing and establishing the long-term cooperation with reliable suppliers, 5) 5S is the foundation of other management tools, 6) cultural diversity provides more available views for the establishment of management strategies, 7) lean manufacturing cannot only improve company's core competition and pursue long-term interests, but it can also increase annual revenue by improving efficiency and reduce costs and waste.

There is a positive relationship between lean manufacturing's application and the performance at Company X, such as improving staff's training and enhancing team work. Among these benefits, the most obvious advantages derive from choosing green suppliers. Firstly, choosing green suppliers has significant value for most manufactur-

ing companies, as it can be regarded as a core competition factor for the company's development. Company X as a typical manufacturing company is well versed in the benefits of green suppliers and aims at building the long-term cooperative relationships. Secondly, on the one hand, the reliable suppliers can decrease the potential threats from unexpected orders and a shortage of supply to the minimum, on the other hand, it may put invisible pressure on business to require that workers pay more attention to the goods quality and waste reduction. Moreover, Company X also focuses on searching potential customers and through improving quality and decreasing waste in the production process to alter potential customers to loyal customers and realizing profit-maximization by pursing waste-minimization.

In this study, the key limitation is that as a case study approach, the results presented only applied to the investigated Company X, however some insights can be provided for other companies within the automotive sector. The use of other methods such as ethnography, cross-sectional survey or observation, for instance, could have provided a better insight on this subject.

Lastly, further research about other Chinese-based cross-cultural automotive companies should be encouraged and developed in order to realize that based on the current situation of lean manufacturing's application in China, are there any feasible measures to be taken in order to make these companies achieve better performance?

References

1. Alukal, G. (2003). Create a lean, mean machine. Quality Progress, 29-35.
2. Aronson, J. (1994). A pragmatic view of thematic analysis. The Qualitative Report, 2(1), 1-3.
3. Berger, A. (1997). Continuous improvement and Kaizen: Standardization and organizational designs. Integrated Manufacturing Systems, 8(2), 110-117.
4. Boyatzis, R, E. (1998). Transforming qualitative information: thematic analysis and code development. London: SAGE Publications.
5. Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77-101.
6. Chen, J., Lee, C., and Fujimoto, T. (1997). Adaptation of lean production in China: the impact of the Japanese management practice. International Research on the Japanese Economy. [Online]. Available at: http://www.cirje.e.u-tokyo.ac.jp/research/dp/97/f27/dp.pdf [Accessed 4th May 2018].
7. Chen, L, X. and Meng, B. (2010). Why most Chinese enterprises fail in deploying lean production. Asian Social Science, 6(3), 52-57.
8. Constas, M. A. (1992). Qualitative analysis as a public event: The documentation of category development procedures. American Educational Research Journal, 29(2), 253-266.
9. Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., and Sheikh, A. (2011). The case study approach. BMC Medical Research Methodology, 11(100), 1-9.
10. Drever, E. (1995). Using Semi-Structured interviews in small-scale research. A teacher's guide. Edinburgh: Scottish Council for Research in Education.
11. Einarsdottir, A. (2017). Analysing text and talk: grounded theory and thematic analysis. York: University of York, 14 February 2017.

12. Eriksson, P. and Kovalainen, A. (2015). Qualitative methods in business research: A practical guide to social research. London: SAGE Publication.
13. Fereday, J. and Cochrane, E, M. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. International Journal of Qualitative Methods, 5(1), 80-92.
14. Gallagher, K, S. (2004). Limits to leapfrogging in energy technologies? Evidence from the Chinese automobile industry. Energy Policy, 34, 383-394.
15. Hines, P. and Rich, N. (1997). The seven value stream mapping tools. International Journal of Operations & Production Management, 17(1), 46-64.
16. Hoop, W, J. and Spearman, M, L. (2004). To pull or not to pull: what is the question? Manufacturing and Service Operations Management, 6(2), 133-148.
17. Imai, M. (1986). *Kaizen: the key to Japan's competitive success*. New York: Random House Business Division.
18. Jones, G, K. and Davis, H. (2000). National culture and innovation: implications for locating global R&D operations. Management International Review, 40(00),11-39.
19. Leininger, M. M. (1985). Ethnography and ethno-nursing: Models and modes of qualitative data analysis. In M. M. Leininger, (Ed). Qualitative research methods in nursing. Orlando, FL: Grune & Stratton.
20. Monden, Y. (1983). Toyota Production System: a practical approach to production management. Norcross: Industrial Engineers and Management Press.
21. Pan, F. and Zhang, Z, G. (2004). Cross-cultural challenges when doing business in China. Singapore Management Review, 26(1), 81-90.
22. Rafferty, J. and Tapsell, J. (2001). Self-Managed Work Teams and Manufacturing Strategies: Cultural Influences in the Search for Team Effectiveness and Competitive Advantage. Human Factors and Ergonomics in Manufacturing, 11(1), l9-34.
23. Shi, X, M. and Wang, J, Y. (2011). Cultural distance between China and US across GLOBE model and Hofstede model. International Business and Management, 2(1), 11-17.
24. Smith, A, H. (2000). Chinese character. H. K.: Joint Publishing Co.
25. Sun, P. (2007). Is the state-led industrial restructuring effective in transition China? Evidence from the steel sector. Cambridge Journal of Economics, 31(4), 601–624.
26. Sun, P., Mellahi, K., and Thun, E. (2010). The dynamic value of MNE political embeddedness: The case of the Chinese automobile industry. Journal of International Business Studies, 41, 1161-1182.
27. Taj, S. (2008). Lean manufacturing performance in China: assessment of 65 manufacturing plants. Journal of Manufacturing Technology Management, 19(2), 217-234.
28. Taylor, S. J. and Bogdan, R. (1984). Introduction to qualitative research methods: The search for meanings. New York: John Wiley & Sons.
29. Thun, E. (2004). Keeping up with the Jones': Decentralization, policy imitation, and industrial development in China. World Development, 32(8), 1289–1308.
30. Tuckett, A, G. (2005). Applying thematic analysis theory to practice: A researcher's experience. Contemporary Nurse, 19(1-2), 75-87.
31. Voss, C., Tsikriktsis, N., and Frohlich, M. (2002). Case research in operations management. International Journal of Operations & Production Management, 22(2), 195–219.
32. Wong, M, L. (2007). The Role of Culture in Implementing Lean Production System. In J. Olbager, and F. Persson, (Eds). International Federation for Information Processing, 413-422.
33. Yin, R. K. (1994). Case study research: design and methods. 2nd Ed. Thousand Oaks, Calif: Sage.