APPLYING DEMATEL TO DISCUSS KEY FACTORS IN SHAPING ORGANISATIONAL CULTURE OF LEAN MANAGEMENT

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ABSTRACT

This study aimed to discuss the factors in shaping organisational culture when an organisation promotes lean management. It also aimed to explore which factors are critical among these factors. This study applied a survey questionnaire methodology, and obtained the consent of ten experts and scholars through purposive sampling. The survey was implemented by respondents completing the questionnaires themselves or through telephone interviews. The data were analysed by applying a decision-making trial and evaluation laboratory to understand the degree of causality and correlation between the criteria. According to the data analysis results, three dimensions – 'Lean management has substantial benefits', 'Prevent process waste', and 'Implement lean management programmes and activities/methods and tools' – had the highest degree of correlation; and three dimensions – 'Lean management has substantial benefits', 'Base your management decisions on a long-term philosophy', and 'Prevent process waste' – had the highest degree of causality. Together these dimensions formed the group of causes. However, the degree of causality of 'Lean management has substantial benefits' was far greater than that of the other dimensions. This indicated its significance and influence. The degree of causality of 'Implement lean management programmes and activities/methods' was far less than that of the other dimensions, indicating that this dimension was the effect and was influenced by the other five dimensions. Overall, 'Lean management has substantial benefits' was the most critical factor with the highest degree of causality and correlation. Regarding management implications, a business organisation must encourage its members to regard this dimension as the most critical element when it promotes and shapes the organisational culture of lean management.

OPSOMMING

Hierdie studie het ten doel gehad om die faktore in die vorming van organisasiekultuur te bespreek wanneer 'n organisasie lenige bestuur bevorder, asook om te ondersoek watter faktore van hierdie faktore van kritieke belang is. Hierdie studie het 'n opnamevraelysmetodologie toegepas en die terugvoer van tien kundiges verkry deur doelgerigte steekproefneming. Die opname is geïmplementeer deur skriftelike vraelyste het of telefoniese onderhoude. Die data is ontleed deur 'n besluitnemingsproef en evaluering toe te pas om die mate van oorsaaklikheid en korrelasie tussen die kriteria te verstaan. Volgens die data-analise resultate het drie dimensies – 'Lenige bestuur het aansienlike voordele', 'Voorkom prosesvermorsing', en 'Implementeer lenige bestuursprogramme en aktiwiteite/metodes en gereedskap' – die hoogste graad van korrelasie gehad; en drie dimensies – Lenige bestuur hou aansienlike voordele in', 'Baseer jou bestuursbesluite op 'n langtermynfilosofie', en 'Voorkom prosesvermorsing' – het die hoogste mate van oorsaaklikheid gehad. Saam het hierdie dimensies die groep oorsake gevorm.

Die mate van oorsaaklikheid van 'Lenige bestuur het aansienlike voordele' was egter veel groter as dié van die ander dimensies. Dit het die betekenis en invloed daarvan bevestig. Die graad van oorsaaklikheid van 'Implementeer lenige bestuursprogramme en aktiwiteite/metodes' was veel minder as dié van die ander dimensies, wat aandui dat hierdie dimensie die effek was en deur die ander vyf dimensies beïnvloed is.Oor die algemeen was 'Lenige bestuur het aansienlike voordele' die mees kritieke faktor met die hoogste graad van oorsaaklikheid en korrelasie. Wat bestuursimplikasies betref, moet 'n besigheidsorganisasie sy lede aanmoedig om hierdie dimensie as die mees kritieke element te beskou wanneer dit die organisasiekultuur van lenige bestuur bevorder en vorm.

1. INTRODUCTION

With the development of globalisation, and with China becoming the world's largest manufacturer, export-oriented industries in Taiwan are facing increasingly fierce market competition. In recent years, surging raw material prices and labour costs have squeezed product profits, further adversely affecting industrial development. Thus enterprises need to transform and upgrade their management to scientific management in order to improve productivity, cut costs, and reduce waste. Lean management is an effective solution for such a plight. The term 'lean management' originated in the Toyota Production System (TPS), developed by Toyota Motor as their business management system for more than 30 years, and operating since the 1950s. It was developed further in the United States (US). In the promotion process and system implementation, lean management involves the continuous enhancement of process improvement, billboard management, and a zero-inventory system. However, the purpose of lean management is to reduce costs.

Taiwan also promotes lean management. The most successful case is the A-team system in the bicycle industry. The system was established when China was attracting the investment of Taiwan manufacturers with low costs, hollowing out the Taiwanese bicycle industry. Giant and Merida collaborated to cope with the dilemma as a result. The system was implemented to encourage supplier members jointly to promote lean management. The number of members also increased from 13 to 22, creating the Taiwanese bicycle industry's second peak [1].

Lean management can positively affect enterprises' business performances [2], including reducing process variation, generation of wastes, and rework time, thus reducing production costs, shortening delivery cycles, and improving process flexibility and output consistency quality. Organisational culture (OC) is a critical factor in the success of lean management [3] [4] [5] [6]. Wilson [7] indicated that, when promoting lean management activities, an enterprise or organisation would need to start changing its production mode and product inspection method – that is, changing employees' work mode and the organisational culture. In this case, an enterprise or organisation must pay continuous attention to its organisational culture. Therefore, it is essential to understand the key factors that shape the organisational culture of lean management. Given the above, this study's purpose was to discuss the elements of organisational cultures of lean management and the degree of correlation between these elements, and to propose the key factors in promoting organisational cultures of lean management.

2. LEAN MANAGEMENT

In 1990, several academics at the Massachusetts Institute of Technology (MIT) introduced the TPS through a lean production system in the book, *The machine that changed the world* [8]. Subsequently, the automobile industry in Europe and America regarded this production system as a global standard to improve productivity [8]. Womack and Jones [9] proposed 'lean thinking', and summarised its five principles: (1) precisely determine the value of a specific product (value); (2) confirm the value stream of each product (value stream); (3) make the value flow smoothly (flow); (4) customers should exert the pull on producers (pull); and (5) seek continuous improvement (perfect). Management teams can make the best use of lean management techniques if they clearly understand these principles. According to Camacho-Minano *et al.* [10], for an organisation, lean management is not only an activity but also a process – an improvement process that is being continuously enhanced. In relation to TPS, Liker [3] applied a 4P model to summarise the 14 principles of Toyota Motor. The 4Ps are philosophy, process, people, and problem-solving, which

form a pyramid, as shown in Figure 1. The bottom layer represents the long-term philosophy of creating value for customers and society; the upper layers illustrate the investment made by Toyota Motor in the lean process, highlighting the reduction of lead time by reducing waste. However, reducing waste and creating values require the joint effort of organisational personnel and partners. The 14 principles form the management system of Toyota Motor. Horikiri Toshio [11] suggested that the current TPS is quite different from the TPS released four decades ago; it has a broader scope, and attaches greater importance to humanity.
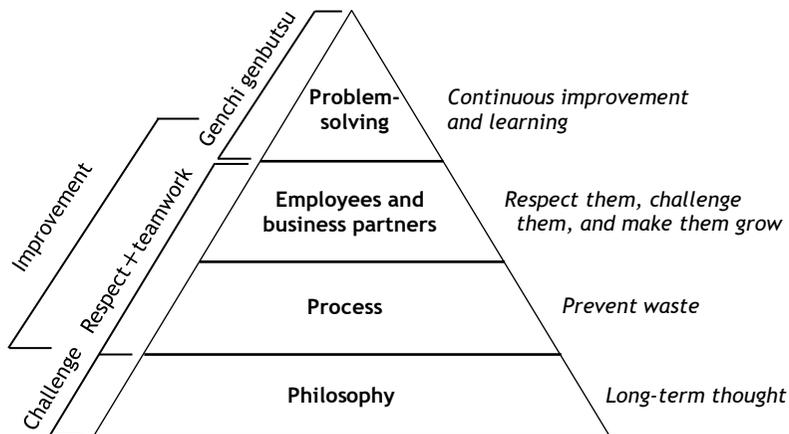
Figure 1: Toyota's 4P model

Table 1 lists the Taiwanese and international studies on lean management. Such studies can be classified into three types: organisational topics, modelling, tool applications, and case studies of lean techniques. Most Taiwanese studies have focused on hard topics, such as tool applications of lean techniques, as shown in Table 1. In contrast, international studies have been evenly distributed, and have focused more on soft topics in executing lean management, particularly organisational topics on lean management promotion.

Table 1: Summary of studies on lean management

	Organisational topics	Modelling	Application of lean techniques and tools and case study
Chen & Chang [12]			x
Jan, Wang, Chen, & Yeh [13]			x
Liao & Lin [14]			x
Lee [15]			x
Li, Oh, & Liu [16]		x	
Hong, Chiang, & Hong [17]			x
Shiau, Wang, Chien [18]	x		
Shiau & Chang [19]			x
Pai, Yeh, Chang, & Cheng [20]	x		
Jing, Miao, & Zhang [21]			x
Number of Taiwanese studies on lean management	2	1	7

Table 1: Summary of studies on lean management (cont.)

	Organisational topics	Modelling	Application of lean techniques and tools and case study
Van der Merwe, Pieterse, & Lourens [22]	x		
Walentynowicz [23]	x		
Salah & Sayed [24]	x		
Bortolotti, Boscari, & Danese [25]	x		
Urban [26]		x	
Coetzee, Van der Merwe, & Dyk [27]	x		
Fourie & Umeh [28]			x
Almanei, Salonitis, & Xu [29]		x	
Bentoa & Tontinia [30]		x	
Iranmanesh, Zailani, Hyun, Ali, & Kim [31]			x
Gazoli de Oliveira & da Rocha [32]			x
Number of international studies on lean management	5	3	3

3. ORGANISATIONAL CULTURE

Organisational culture is a complex, integrated form of intellectual capital [33]. A company's organisational culture reflects its shared values, beliefs, symbols, rituals, and traditions. Table 2 compares the research contents of models of organisational culture. The first two models directly interpret the organisational culture type and are direct application-type tools. The models of Rousseau [34] and Schein [35] [36] fit this study. Schein indicates that all layers of organisational culture are correlated. This study adopted the three-layered model of Schein to discuss the correlation between the three layers and to identify the key factors between them.

Table 2: Comparison of organisational culture models proposed by different scholars

	Key to organisational culture modelling	Attribute
Deal & Kennedy [37]	'Operational risk' and 'Responsiveness of organisation and employees to the success of a strategy'.	Directly interpret the organisational culture type.
Denison & Spreitzer [38]	The flexibility-stability axis reflects the competing demands of change and stability. The internal-external axis focuses on activities happening in or outside the organisation.	Directly interpret the organisational culture type.
Rousseau [34]	Express implicit cultural connotation to explicit behaviours and artefacts from the inside out.	Interpret and analyse phenomena from different layers of organisational culture.
Schein [35] [36]	Use different layers for analysis. 'Layers' refers to the different degrees of cultural phenomena when engaging in or observing an organisation.	Interpret and analyse phenomena from different layers of organisational culture.

4.   LEARN CULTURE

Wilson [6] indicated that an organisation should preferentially master leadership, incentive, problem-solving, all staff participation, and a learning/education/experiment environment before implementing lean culture reforms. An organisation should also pay attention to three cultural features. First, all reforms are interdependent: when an organisation changes an aspect of its culture, other aspects will also change accordingly. This will be more significant in lean transformation. Second, an organisation must be determined to solve fundamental issues. Third, an automatic deduction may be a key issue that does not receive adequate attention. The input of senior leaders is of great significance in initiating and maintaining lean management in an organisation [39], including formulating and implementing a promotion framework and process; these can prevent or help to cope with cross-department lean transformation issues and increase the opportunity for a successful continuous improvement process. Saha *et al.* [40] suggested that the changes in staff attitudes and thoughts and in organisations' willingness to accept lean transformation contribute to 80% of the success of lean management. Van der Merwe *et al.* [22] built a lean culture reform framework, and discussed 12 factors. First, a good cause for promoting lean reform must be declared, the necessity of change must be declared, and a communication scheme must be formulated to communicate the cause of the change. Continuous communication and coordination are required to shape the organisational culture with other factors.

5.   RESEARCH DESIGN

5.1. Framework of the organisational cultures of lean management

Miller *et al.* [41] modified Schein's [36] model in discussing lean improvement culture to reflect the experience in three layers: artefacts, behaviours, and core beliefs, in an improved environment. The three layers were called the 'ABCs of organisational culture'. We adopted the three-layered model proposed by Schein as this study's framework. Schein analysed organisational culture based on the following three layers: underlying assumptions, values and beliefs, and artefacts, as shown in Figure 2. These layers allow us to see different degrees of cultural phenomena when engaging in or observing an organisation. Moreover, they illustrate specific and explicit behaviours arising from in-depth and imperceptible underlying assumptions (i.e., the essence or DNA of culture), to quote the layered relationship corresponding to the organisational culture of lean management. Schein [36] found that a successful organisational culture comes from leaders' behaviours; a leader can initially influence members of an organisation with their own beliefs and values. An organisational culture will not be formed if its values are irrelevant to organisational behaviours. In contrast, the organisation will be more successful and stronger if its values fit in and influence employee behaviours. Members will believe that the values will lead the organisation to success.
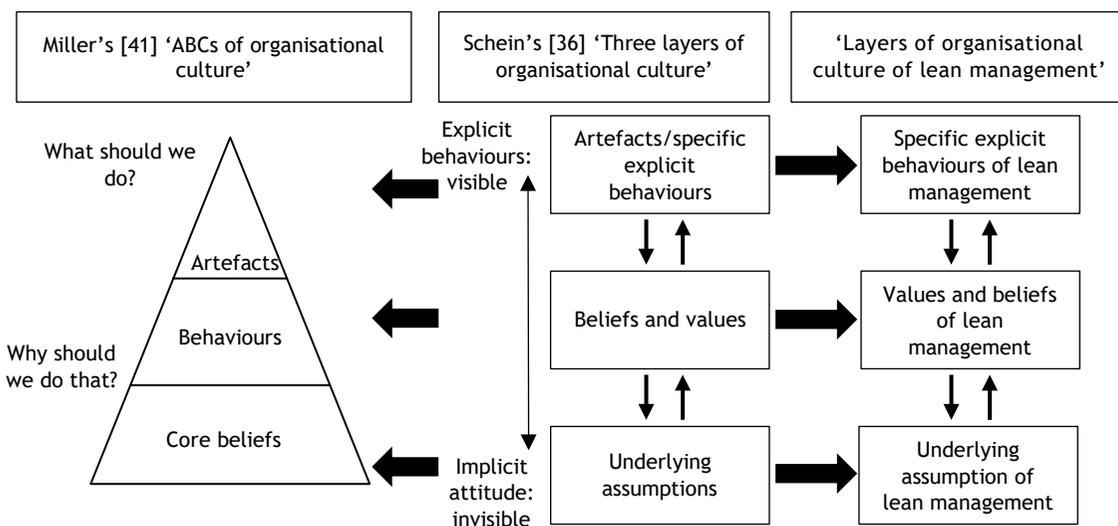
Figure 2: Framework of organisational culture of lean management

5.2. Decision-making trial and evaluation laboratory

The decision-making trial and evaluation laboratory (DEMATEL) is a method developed at the Battelle Memorial Institute of Geneva from 1972 to 1976 for its science and human affairs programme. DEMATEL is an effective method for building and analysing a structural model, and is often applied to explore the relationship between social phenomena and to solve complex issues between criteria. It can effectively combine expertise to clarify the correlation between variables. DEMATEL can convert the causality among criteria into a clear structural model, and address the interdependency and degree of influence among the criteria of the series. In recent years, DEMATEL has been widely applied to solving various complex issues [42].

5.3. Questionnaire design

The first layer of organisational culture involves the underlying assumptions. Similar to people's perception of essential demands, an organisational culture will become unconsciously ingrained in the mindset of the members of an organisation over time, or their basic perception of truth. Furthermore, comparing and arguing over underlying assumptions is impossible, much like applying theories. Therefore, it is difficult to change underlying assumptions. This study's underlying assumption on lean management states that promoting lean management offers significant benefits and contributions, and will be imperceptibly transmitted to the mindset of people.

The second layer of organisational culture relates to lean management values and beliefs, including strategies, objectives, social harmony, and a specific thinking philosophy with internal organisational characteristics. The values are an individual behavioural code and a behavioural code that all members should abide by. Compared with organisational culture, 'lean management culture' refers to decomposing cultural layers from the perspective of lean management. This study used Liker's [3] 4P model (14 principles) to design the survey questions shown in Table 3. Each member of an organisation must have this core value and shared belief. In addition, consent to this core value has to reach from the lowest layer to the highest executive layer.

The third layer concerns artefacts or specific and explicit behaviours. These behaviours refer to the methods that can be seen or felt to practise the underlying assumptions and value layers of lean management or specific programme implementation behaviours. Artefacts or specific and explicit behaviours can also be regarded as explicit actions or behaviours for achieving lean management practices, such as standardised and rationalised operations, lean process, or process management, applying lean tools, equipment management, specific action plans, multifunctional labour planning, supply chain management, result performance management, and the organisation and implementation of quality improvement activities.

Table 3: Organisational culture criteria: Questions and codes

Three layers of organisational culture	Criterion and code		
Underlying assumption	A Lean management has substantial benefits		
Beliefs and values	B Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals		
	C Prevent process waste	C-1 Create a continuous process flow to bring problems to the surface.	
		C-2 Use pull systems to avoid overproduction.	
		C-3 Level out the workload (work like the tortoise, not the hare).	
		C-4 Build a culture of stopping to fix problems to get quality right the first time.	

Table 3: Organisational culture criteria: Questions and codes (cont.)

Three layers of organisational culture	Criterion and code	
Beliefs and values		C-5 Standardised tasks and processes are the foundation for continuous improvement and employee empowerment.
		C-6 Use visual controls, so that no problems are hidden.
		C-7 Use reliable, thoroughly tested technology that serves your people and process.
	D Focus on employees and business partners	D-1 Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.
		D-2 Develop exceptional people and teams who follow your company's philosophy.
		D-3 Respect your extended network of partners and suppliers by challenging them and helping them to improve.
	E Continuously improve and solve problems	E-1 Go and see for yourself to understand the situation thoroughly.
		E-2 Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly.
		E-3 Become a learning organisation through relentless reflection and continuous improvement.
Explicit behaviours	F Implement lean management programmes and activities/methods and tools	

5.4. Respondents

This study conducted purposive sampling from January to February 2022, and invited ten experts and scholars in lean management-related fields to participate in the survey questionnaire. Table 4 lists the background information of these experts and scholars: four industry experts, two academic professors, and four experts from research institutes.

Table 4: Background information of respondents

	Employer	Title	Note
1	Electronics company	Chairman	The company has been promoting lean management activities for more than 15 years
2	Semiconductor company	Vice president	The company has been promoting lean management activities for more than 12 years
3	Private consulting firm	Senior consultant	Advising industry lean management
4	Department of Industrial and Systems Engineering of A University	Professor	Teaching lean management/acting as a judge in a continuous improvement contest
5	Department of Industrial Engineering and Management of B University	Professor	Teaching lean management/acting as a judge in a continuous improvement contest

	Employer	Title	Note
6	Corporate consulting firm A	Senior consultant	Advising industry lean management
7	Corporate consulting firm B	Technical manager	Teaching lean management/acting as a judge in a continuous improvement contest
8	Corporate consulting firm B	Technical director	Teaching lean management/acting as a judge in a continuous improvement contest
9	Bicycle company	General manager	The company has been promoting lean management activities for more than 17 years
10	Machine tool company	General manager	The company has been promoting lean management activities for more than nine years

6.   RESULTS AND ANALYSES

The criteria that a decision-maker relies on may be interdependent. Such interdependency can influence a decision-maker's judgement. This study applied DEMATEL to discuss the interdependency between the dimensions of the organisational culture of lean management and 16 variables to identify the key factors.

6.1. Discussing the degree of correlation and causality between dimensions of organisational culture of lean management

Regarding the degree of correlation (r+d), Table 5 indicates that 'Underlying assumption of lean management – Lean management has substantial benefits' (12.8862) had the largest number of influencing and influenced scopes. Therefore, it had a higher degree of influence than the other dimensions. However, 'Focus on employees and business partners' (11.5482) had the smallest degree of correlation, indicating that it had the smallest influence on the other dimensions.

Regarding the degree of causality (r-d), the degree of causality of 'Underlying assumption of lean management – Lean management has substantial benefits' (1.0804) was the greatest, and was greater than 0. This indicated that it was a causal factor, as a company must believe that lean management can bring substantial benefits when promoting it. However, the degree of causality of 'Specific, explicit behaviours of lean management – Implement lean management programmes and activities/ methods and tools' was the smallest, and was less than 0. This indicated that it was influenced more by other dimensions, and was an effect factor.

Table 5: Analysis of the degree of correlation and causality between dimensions

	A	B	C	D	E	F	r	r+d	r-d
A	0.9856	1.1187	1.2132	1.1473	1.2207	1.2978	6.9833	12.8862	1.0804
B	1.0647	0.8675	1.1105	1.0646	1.0984	1.1956	6.4013	12.0671	0.7355
C	1.0250	0.9813	0.9363	1.0407	1.0935	1.1893	6.2662	12.5189	0.0135
D	0.9186	0.8792	0.9575	0.7958	0.9612	1.0563	5.5687	11.5482	-0.4109
E	0.9564	0.9036	1.0179	0.9595	0.8683	1.1037	5.8094	12.0607	-0.4419
F	0.9526	0.9155	1.0173	0.9715	1.0092	0.9421	5.8083	12.5931	-0.9765
d	5.9029	5.6658	6.2527	5.9795	6.2513	6.7848			

Based on the causality diagram of the six dimensions of the organisational culture of a lean management model, the threshold value of the influence relationship matrix was calculated to be 1.0233. The data were screened according to this threshold value. The influential relationships among the dimensions were presented on the causality coordinate chart. Overall, if the value of a dimension was greater than the threshold, the dimension had a larger scope of influence. In contrast, if the value of a dimension was lower than the threshold, the dimension had a smaller scope of influence. The value determined the direction of an arrow in the threshold value determination table. If the threshold values between two dimensions were greater than 1.0233, the relationship between the two dimensions was a mutual influence, and was marked with a double-headed arrow. If one dimension influenced the other, the relationship was represented by a single-headed arrow. However, it is possible that this dimension also influenced or was influenced by different dimensions. Figure 3 shows that there was complex causality among the six dimensions. In particular, 'Lean management has substantial benefits', 'Prevent process waste', and 'Implement lean management programmes and activities/methods and tools' were in the right part of the causality chart concerning the degree of correlation, and the arithmetic average of the degree of correlation was 12.279. Therefore, these three dimensions had a large scope and degree of influence.

If the degree of causality of a dimension was greater than 0, this dimension would be a causal factor and influence or mutually influence other dimensions to a large extent. The calculation result indicates that the degree of causality of 'Lean management has substantial benefits', 'Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals', and 'Prevent process waste (Process)' was greater than 0. Therefore, importance should be attached to developing these three dimensions in promoting and shaping the organisational culture of lean management. In particular, the degree of causality of 'Lean management has substantial benefits (1.0804)' was far greater than that of other dimensions, indicating its significance and influence. The degree of causality (r-d) of 'Focus on employees and business partners', 'Continuously improve and solve problems', and 'Implement lean management programmes and activities/methods and tools' was less than 0, indicating their inclination toward affected elements. In particular, the degree of causality of 'Implement lean management programmes and activities/methods and tools (-0.9765)' was far less than that of other dimensions, indicating that the other five dimensions influenced it.
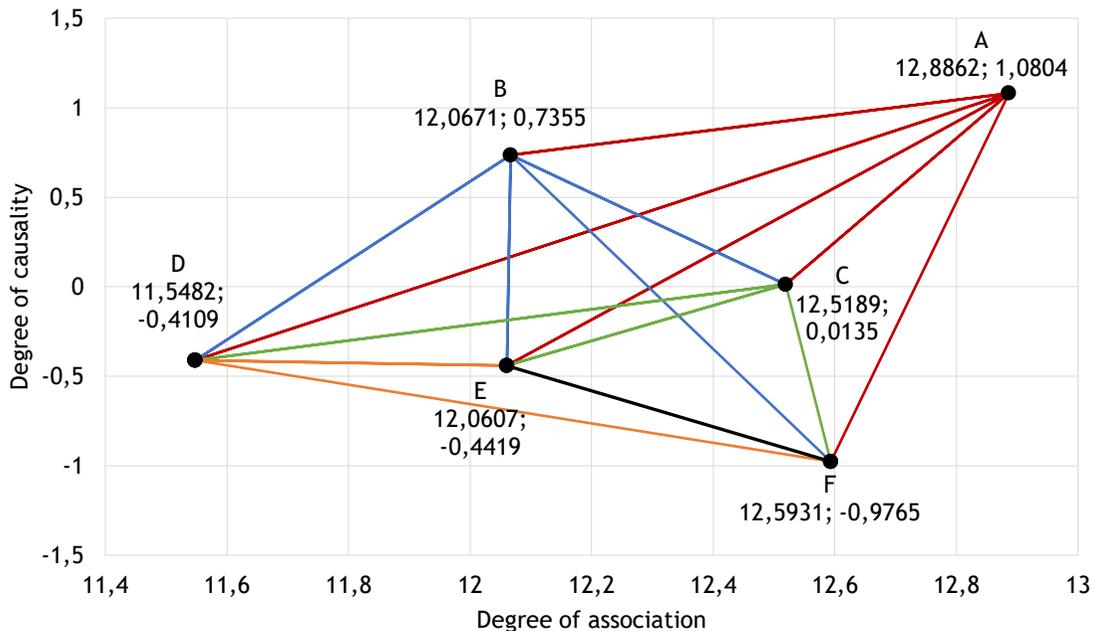
Note: A Lean management has substantial benefits; B Base your management decisions on a long-term philosophy even at the expense of short-term financial goals; C Prevent process waste; D Focus on employees and business partners; E Continuously improve and solve problems; F Implement lean management programmes and activities/methods and tools

Figure 3: A causality diagram of the six dimensions of organisational culture of a lean management model

Overall, the 'Underlying assumption of lean management-Lean management has substantial benefits' has the highest degree of correlation and degree of causality, indicating that this dimension is the most critical factor in the organisational culture of a lean management model. The degree of correlation of 'Implement lean management programmes and activities/methods and tools' is second to the underlying assumption. Moreover, the arrows of all other dimensions point to this explicit behaviour. Therefore, we can interpret that the 'Underlying assumption of lean management' and 'Lean management beliefs and values' will influence 'Specific, explicit behaviours of lean management' (Implement lean management programmes and activities/methods and tools). This also demonstrates that the organisational culture of a lean management model developed in this study is verifiable.

6.2. The degree of correlation and causality of second-order factors

This study examined further the degree of correlation and causality of second-order factors. As listed in Table 6, the top three factors measured by the degree of causality were: A: Lean management has substantial benefits (0.616); B: Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals (0.360); and C-7: Use only reliable, thoroughly tested technology that serves your people and process (0.508). In particular, the degree of causality of the 'Underlying assumption of lean management – Lean management has substantial benefits' is relatively greater than that of the other factors, indicating that it is a critical influencing factor.

The top three factors measured by the degree of the correlation were: A: Lean management has substantial benefits (15.822); C-3: Level out the workload (work like the tortoise, not the hare) (15.350); F: Implement lean management programmes, activities/methods, and tools (15.281), indicating that these three factors were highly associated with other factors. In particular, 'Underlying assumption of lean management – Lean management has substantial benefits' had the highest degree of correlation and influence, indicating that it was a significant factor in the organisational culture of a lean management model.

Table 6: Influence and causality of second-order factors

No.	Influence criterion	r	d	r+d	r-d
A	Lean management has substantial benefits.	8.219	7.603	**15.822(1)**	**0.616(1)**
B	Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals (Philosophy).	7.483	7.124	14.607(13)	**0.360(3)**
C-1	Create a continuous process flow to bring problems to the surface.	7.515	7.436	14.951(9)	0.079(6)
C-2	Use 'pull' systems to avoid overproduction.	7.620	7.617	15.237(5)	0.004(7)
C-3	Level out the workload (work like the tortoise, not the hare).	7.752	7.598	**15.350(2)**	0.154(5)
C-4	Build a culture of stopping to fix problems to get quality right the first time.	7.440	7.456	14.896(10)	-0.016(8)
C-5	Standardised tasks and processes are the foundation for continuous improvement and employee empowerment.	7.361	7.63	14.991(8)	-0.269(13)
C-6	Use visual controls, so that no problems are hidden.	6.491	6.614	13.105(16)	-0.123(9)
C-7	Use only reliable, thoroughly tested technology that serves your people and process.	6.992	6.484	13.476(15)	**0.508(2)**
D-1	Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.	7.267	6.917	14.184(14)	0.350(4)
D-2	Develop exceptional people and teams who follow your company's philosophy.	7.220	7.464	14.684(12)	-0.244(12)
D-3	Respect your extended network of partners and suppliers by challenging them and helping them to improve.	7.222	7.629	14.851(11)	-0.407(16)

Table 6: Influence and causality of second-order factors (cont.)

No.	Influence criterion	r	d	r+d	r-d
A	Lean management has substantial benefits.	8.219	7.603	**15.822(1)**	**0.616(1)**
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D-2	Develop exceptional people and teams who follow your company's philosophy.	7.220	7.464	14.684(12)	-0.244(12)
D-3	Respect your extended network of partners and suppliers by challenging them and helping them to improve.	7.222	7.629	14.851(11)	-0.407(16)
E-1	Go and see for oneself to understand the situation thoroughly.	7.554	7.71	15.264(4)	-0.157(10)
E-2	Make decisions slowly by consensus, thoroughly consider all options, and implement decisions rapidly.	7.403	7.718	15.120(7)	-0.315(14)
E-3	Become a learning organisation through relentless reflection and continuous improvement.	7.489	7.646	15.134(6)	-0.157 (10)
F	Implement lean management programmes and activities/ methods and tools	7.449	7.832	**15.281(3)**	-0.383 (15)

Note: Values in brackets are ranked in descending order.

7. CONCLUSION

Organisational culture cannot be shaped overnight. In the process of promoting lean culture in Taiwan, most business organisations promote lean management-related activities and gradually form an organisational culture based on the empirical performance of the industry as determined by the management. Some scholars have suggested that developing an ideal culture depends on conscious actions [43] [44]. Therefore, regarding the underlying assumption, we need to assume that the promotion of lean management can form beliefs and values and drive explicit implementation behaviours only if it can bring substantial benefits.

This study applied the three-layered model developed by Schein [35] [36] to reveal the relative hierarchy of the organisational culture of lean management. This study discussed the correlation among the three layers, based on the opinions of ten experts from industry, universities, and research institutes by applying DEMATEL. According to the correlation analysis, 'Lean management has substantial benefits', 'Prevent process waste', and 'Implement lean management programmes and activities/methods and tools' had a large scope and degree of influence. According to the causality analysis, 'Underlying assumption of lean management – Lean management has substantial benefits', 'Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals', and 'Prevent process waste (Process)' were causal factors. Therefore, importance should be attached to developing these three dimensions in promoting and shaping the organisational culture of lean management. In particular, the degree of causality of 'Lean management has substantial benefits' is far greater than that of the other dimensions, indicating its significance and influence. The degree of causality of 'Implement lean management programmes and activities/ methods and tools' was far less than that of the other dimensions, indicating that it was an effect factor and was influenced by the other five dimensions. According to the threshold value analysis, there was a mutual influence between 'Lean management has substantial benefits' and 'Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals' and between 'Lean management has substantial benefits' and 'Prevent process waste (Process)'. A double-headed arrow denotes these results. This also indicates a layered process of organisational cultures from implicit cognition to corporate principles and explicit behaviours with complex correlations.

The top three factors measured by the degree of the correlation of the second-order factors were (in descending order): 'Lean management has substantial benefits', 'Level out the workload (work like the tortoise, not the hare)', and 'Implement lean management programmes, activities/methods, and tools', indicating that these three factors were highly associated with the other factors. In particular, 'Underlying assumption of lean management – Lean management has substantial benefits' had the highest degree of correlation and influence, indicating that it was a significant factor in the organisational culture of a lean management model. The value of the factor 'Level out the workload (work like the tortoise, not the hare)' belonging to 'Prevent process waste' ranked second, which was different from the ranking of the correlation analysis between the dimensions. It could explain that 'Level out the workload (work like the tortoise, not the hare)' had the highest correlation with other items among the many factors of 'Prevent process waste' in promoting lean management activities, and that its correlation value was similar to 'Implement lean management programmes and activities/methods and tools'.

Overall, 'Lean management has substantial benefits' was a critical factor with the highest degree of correlation and causality. Regarding management implications, a business organisation should encourage its members to consider this dimension as the most critical element when it promotes and shapes the organisational culture of lean management. Therefore, management could enable members to develop a shared recognition of performance through other successful cases, benchmarking the learning, or adopting lean management tools that are useful in obtaining substantial benefits in time, in addition to believing that lean management would bring significant benefits. The degree of correlation of 'Implement lean management programmes and activities/methods and tools' was second to the underlying assumption. The other dimensions would also influence this explicit behaviour. This also demonstrated that the organisational culture of a lean management model developed in this study was verifiable.

This study was preliminary. Experts from industries, government, universities, and research institutes assessed the overall framework. Subsequent studies could apply structural equation modelling (SEM) to discuss the causality between the three-layered attributes in the organisational culture of lean management to compare them at the same level. The assessment framework could also be introduced in various industries for empirical studies among enterprises. As a result, the research framework would be more complete and would fit industry demands better. Organisational development will have different scales with different stages; and we could explore whether companies of different sizes have differences in promoting a lean organisational culture. Furthermore, we could analyse whether there are differences in the implementation and benefits of organisations in the actual use of lean management in explicit behaviours.

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