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Lean principles adoption in environmental management system (EMS): A survey on ISO 14001 certified companies in Malaysia

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Abstract:

Purpose: The purpose of this study is to examine the characteristic of the lean principles in ISO 14001 and to propose linkage between lean principles and ISO 14001.

Design/methodology/approach: To achieve the objective of the study, literature survey and quantitative research method using questionnaire survey are used.

Findings and Originality/value: The findings of this study confirm that ISO 14001 certified company adopted lean production practices. The study also proves that lean principles have a positive and significant relationship with ISO 14001 EMS and the linkage can be made between lean principles and ISO 14001 to achieve Continual Improvement.

Research limitations/implications: The small sample sizes of the participating companies are the main limitations of this study and this research mainly focus on the manufacturing environment and services industry in Malaysia.

Practical implications: This research shows that all ISO 14001 companies do adopt at least one of lean production practices and the main findings are lean principles has positive and highly significant relationship with ISO 14001 requirements. This is because the integration of lean principles in ISO 14001 will serve practical methods for ISO14001 EMS to achieve the continual improvement.

Originality/value: This research is amongst the first to study on the combination of lean principles with ISO 14001. Based on the current situation, there is no integration between this two management system.

Keywords: Lean Principles, EMS, ISO 14001, Integration.

1. Introduction

Management practices in the recent days have undergone rapid transformations owing to global changes taking place. The focus of organizations has been on increasing operational efficiency, reducing costs, enhancing quality levels, ensuring steady profits, and meeting customer needs. The efforts of the management in the recent times have been on enhancing productivity through efficient methods of production that emphasizes on the elimination of unnecessary procedures and processes that add to production costs. The efficiency of production process determined by the optimal use of resources and adopting an environmentally friendly production method. Environment management systems or EMS has been the focal point of management strategies in most organizations today.

EMS practices within an organization need to be integrated with exiting organizational practices to realize its true potentials. Research studies have revealed that the majority of organizations focuses more on gaining market competitive advantage, improving customer relations, and increasing profit potentials than adopting work processes that satisfy environmental safety and policy requirements.

Lean is one such business model that focuses on delivering quality products to the customer at reduced cost of production. The principles of Lean are founded on understanding of customer needs and demands, eliminating non-value added activities from the production process, involving the workforce in resolving operational issues, define metrics for measuring organizational performance, assist in the decision making process and problem solving (Ross & A.E.C, 2004).

ISO 14001 is the world's most recognized EMS framework that helps organizations both to manage better the impact of their activities on the environment and demonstrate sound environmental management. ISO 14001 is designed to be flexible enough to be applied to any size of organization in both the private and public sectors by Montabon, Meinyk, Stroofe and Calantone (2000).

The organization of this paper is as follows. Section 1 is the introduction. Section 2 literature review. Section 3 presents the research methodology. Section 4 results. Section 5 discussion. Section 6 presents conclusions, recommendation and future research.

2. Literature review

The literature review will focus on identifying the various aspects of Lean and EMS systems, ISO 14001 standards and its prospective business applications. Lean principles encourage an organisation to bring about significant changes in their operational and cultural environment. This in turn has a positive impact on the environmental performance of the company reducing pollution, waste and emissions. Lean principles enable companies to deliver with lesser resources resulting in lesser scrap and wastage. It encourages organisations to judiciously use natural resources, such as energy, water and forest products. Lean pushes for continuous improvement and empowers companies to better their environment performance (Environment Protection Agency, 2010).

It can be seen that Lean principles and ISO 14001 standards have a lot of common ground and both aim at reducing waste. Lean focuses on delivering the maximum value to the customer using the required resources at minimizing waste. When an organisation implements Lean, there are significant cost savings. There is optimum utilization of resources and wastage is reduced. This has a positive impact on the environmental performance of the company. When a company is implementing Lean principles into EMS, it must clearly set forth the objectives of such an initiative (Mc Donald, 2005). The senior management must play an important and visible role in implementing the Lean and green initiatives. The procedures and measures for attaining the goals must be clearly communicated to the employees at all levels. There must be cross functional cooperation in the organisation to learn and benefit from mutual experience. There should be a process of acknowledging the best practices of each unit and introducing the same at the company level. A company can benefit tremendously from combining the Lean and green efforts. The company will be seen as contributing to protecting the environment and preserving it for future generations. It will result in reduced cost of operations, optimum utilization of resources, reduction in wastage and better profitability for the organisation.

2.1. Environmental Management System (EMS)

In the 21st century, there is great emphasis on companies and businesses to contribute towards protecting the environment as part of their corporate social responsibilities. Companies need to adopt measures to protect and enhance the environment in order to maintain good relations with customers, suppliers and vendors. There is a growing need for businesses to fulfil their corporate social responsibilities in order to survive in the global economy. Environment management system (EMS) can help the company in fulfilling their responsibilities towards protecting the world environment (Gbedemah, 2004). An EMS provides the framework to manage the company's environmental responsibilities effectively and also helps in integrating the environmental initiatives into the day to day operations. An efficient EMS is critical to all types of business irrespective of the nature, size and scale of operations.

In the global market, it is important for manufacturing, automotive, retail and service industries to have an EMS in place. An effective EMS contributes to cost savings and reduces the environmental liabilities (Cheremisinoff, Rosenfeld and Rosenfeld, 2010). It also helps in ensuring that employees, suppliers and vendors understand their role in the environmental policy and contribute effectively towards meeting the environmental objectives of the organization (Visser, Matten, Tolhurst & Pohl, 2010).

2.2. ISO 14001 standard and principles

ISO 14001 is an internationally accepted standard that sets out the steps to be taken by a business to put in place an effective EMS (Environmental Protection Agency, 2002). It helps in integrating the environmental goals into the overall operations of the company. ISO 14001 standards were written by consensus of nearly 50 countries and more than 100 countries have endorsed it as an international standard. ISO 14001 is applicable to all types of organizations with varying nature and size of operations. It is also relevant to companies with different risk profiles. It is easily adaptable either to an entire organization or a specific function (Woodside & Aurrichio, 2000). ISO 14001 has become an administrative tool towards corporate environmental management (Puvanasvaran, Muhamad & Kerk, 2010). It also helps in reducing insurance and prosecution risks. ISO 14001 helps in gaining investor confidence and brings in more ethical investment (Whitelaw, 2004).

2.3. Lean system

Lean is a tool for process improvement that aims at maximizing customer value and minimizing waste (Miller, Pawloski & Stanridge, 2010). Lean helps in focusing on key processes that affect the output to the customer. It focuses on continuously improving the process management elements to deliver maximum value to customers. Lean helps in achieving the organizational goals with fewer resources and zero waste. Lean does not focus individually on systems, tools, technologies, assets and functions. It works on optimizing the process flow across assets, systems, technologies and functions to deliver the best value to customers (Lean Enterprise Institute, 2009).

Earlier, lean principles were thought to be relevant only to manufacturing companies. This is no longer true. Lean can be implemented successfully across all industries. To reap the full benefits of lean, the company must adopt it as part of their business strategy (Turbide, 2005). This will result in lean principles being implemented consistently across all the functions in the organization and will have a positive impact on the overall performance.

Lean should be adopted as a way of thinking and as a way of doing business in order to fully enjoy its benefits (Sarkar, 2007). According to Reidenbach & Goeke (2006, pp. 1), "Rather than having cost reduction as the exclusive focus of lean thinking, the conceptual framework of

lean also has tremendous potential for increasing top-line revenue by creating a sustainable differential value advantage for the enterprise that deploys the concept in its entirety."

2.4. Integrating lean into ISO 14001

Earlier it was thought that lean and EMS has different objectives and hence cannot be integrated. A company would implement its lean and EMS initiatives separately with a view that the two target different kind of waste. Lean involves implementation of measures for optimizing the process flow and minimizing waste. EMS is aimed at putting policies and procedures in place to reduce the adverse effect on the environment. Subsequently, studies have shown the strong relationship between the lean and green activities in an organization. Both lean and green initiatives share a common goal of reducing wastage. The wastage defined in lean management also has significant environmental impact. Implementation of lean principles will have a positive impact on the company's environmental performance. A business should take a holistic approach in implementing an EMS and integrate the lean principles to the environmental aspects of the company. Companies should work towards fostering an effective relationship between the lean and green activities to maximize customer satisfaction and minimize waste (Mitsuishi, Ueda & Kimura, 2008).

For the lean principles to be integrated into the ISO 14001 standards in an organization, the environment policy and lean objectives must be clearly defined. A well defined system must be in place setting out the roles and responsibilities of the employees in different departments across various levels. The employees should clearly know what their lean and green goals are and the means to achieve them. This helps in reducing the time and effort spent on searching for solutions (Gordon, 2001).

The process of integrating Lean into the EMS is a multi-layered process and involves many steps. The first step is listing those areas of function in the company which has the largest environmental impact. The business should ensure that the Lean principles are integrated into those processes that impact the environmental performance. The next step is creating awareness amongst the employees about the Lean and green efforts of the company. Employees must be made to feel that their company does really care about the environment and not merely undertaking to implement an EMS for ISO certification. They must be able to see and understand the vision of the company in integrating Lean principles into ISO 14001 standards. Employees must be fully aware of the course of their actions and their environmental impact. Another important factor for deriving the system successfully was the employee problem solving capability (Puvanasvaran, Megat, Tang, Muhamad & Hamouda, 2008). Top management commitments play a very important role and have a strong relationship with problem solving capability (Puvanasvaran, 2009). It is only with this understanding that organisations can get the full support and participation of the employees in integrating Lean principles into the EMS (Gordon, 2001).

The company should work on integrating the EMS requirements into the existing systems. If a separate process flow is created for EMS, there could be issues of lack of coordination between the environmental measures and other processes. The procedures and measures for attaining the goals must be clearly communicated to the employees at all levels. The study done by Puvanasvaran, Kerk and Muhamad, (2011) effectiveness of integrating Lean and EMS can be realized by adopting processes and procedures designed to eliminate waste and create an economically sustainable work environment.

3. Research methodology

The research design is one of the key factors in determining the effectiveness of the research study. If the method applied does not meet the needs of the objectives, the findings and analysis of data collected are wasted. A mixed method of Qualitative and Quantitative research design would be employed. The Review of current literature will provide a meaningful addition to the qualitative aspect of the study, while survey questionnaire will contribute to the quantitative aspect of the study. The purpose of this study is to ensure internal and external validity of the study with Cronbach's Alpha. This study conducted using the cross-sectional survey which is the most appropriate tool to be used. Information of this study was gathered from various ISO 14001 certified companies in Malaysia. The best approach to gather data for this study is through a survey by distributing questionnaires to the respondents. The set of questionnaire is designed to collect the data and information needed in this study.

3.1. Questionnaire development

The questionnaire development is done by referring to all the data gather such as literature review, books, and etc. For this study, the questionnaire was divided into two sections. Section A and Section B.

In the first section of the questionnaire, the question was developed by referring to previous study conducted by Puvanasvaran, Megat, Tang and Muhamad (2009); Boyer (1996). It is used to identify the ISO 14001 certifies companies adopted the lean production practices. In the second section of the questionnaire, the questions were developed from Womack et al. (1990) and Malaysian Standard Environmental System (EMS) requirement with guidance for use (ISO 14001:2004). The second section of the questionnaire was used to measure the positive and significant relationship of lean principles with the ISO 14001 requirement.

3.2. Pilot test

Pilot test conducted to ensure that the result of the questionnaire is valid and meet the objective of the research. This is done by sending the questionnaire to 10 ISO 14001 certified companies around Melaka. Discussion of the questionnaire was held when the company was visited. Opinion was given which help the researcher to modify the existing questionnaire. Besides that, from the pre-test, the total time spend with the company also can be identified.

3.3. Sending and receiving questionnaire

In this study, data was obtained only from primary sources. Primary data in this context refer to the information obtained first hand by the researcher on the variables of interest for the specific purpose of this study. In this study, the primary data obtain from the ISO 14001 certified companies around Malaysia. The data collection method used is questionnaire.

A questionnaire is a pre-formulated written set of questions which respondents record their answers. This study is preferred to use this method because it is easy for the researcher to get the information. In addition by using this method, it is less costly compared to other methods. Type of question asked in the questionnaire is close-ended. This is to make sure the respondents easy to fill in the answer and state in the questionnaire. In the questionnaire, Likert scale questions will be used. The questionnaire was distributed around May 2011 and the process of distributing and collecting the questionnaires takes around 8 weeks.

The data were collected from ISO 14001 certified company in Malaysia. The list of the 420 ISO 14001 certified company was collected from the Malaysian Certified Database. A total of 140 questionnaires were mailed by hand into the respondent. With close follow up by telephone call, email, and personally meet up with the respondent to hand in and collected the questionnaires, only 48 completed questionnaires was received. Clear instructions were given to ensure individual selected as respondents must be those involved with the ISO 14001 in their respective company.

3.4. Data analyzing

The data analysis flow chart in the Figure 1 shows the data analysis process. From the data collection, feel for data, goodness of data, hypothesis testing to the interpretation of the result, the step and flow can be seen.

There are a number of different reliability coefficients. One of the most commonly used is Cronbach's alpha (Coakes, 2005). It is used to assess the internal consistency reliability of several items or scores that the researcher wants to add together to get a summary or summated scale score (Morgan et al., 2004). Cronbach's alpha is based on the average correlation of items within a test if the items are standardized (Coakes, 2005). The alpha value

should be positive and usually greater than 0.70 in order to provide good support for internal consistency reliability (Morgan, Leech, Gloeckner & Barret, 2004).

In this study, the first part of the questionnaire, the mean and standard deviation were computed with the scores of the eight variables. The mean is the value of the degree of adoption of lean production practices in the ISO 14001 certified company. The percentage of each variable also has been measure to support the value of the mean and standard deviation.

In the second part of the questionnaire, reliability coefficients, descriptive statistics, and correlation will do to measure the relationship of lean principles with the ISO 14001 requirement. Correlations measure how variables are related. Before calculating a correlation coefficient, data is screened for outliers and evidence of a linear relationship. Pearson's correlation coefficient is a measure of linear association. If the relationship is not linear, Sprerman's rho will be used to measure the correlation between the variables (Morgan et al., 2004). A Pearson correlation coefficient describes the relationship between two continuous variables. A correlation between two dichotomous or categorical variables is called phi-coefficient (Coakes, 2005). Correlation is measured between each variable of the lean principles that is value, value streams, flow, pull and perfection with the ISO 14001 requirement.

Reliability Test, Descriptive Statistics and Correlation are used for this study. The Statistical Package of The Social Science (SPSS version 19) uses to record, analyse and interpret raw data. The data obtains were compiled, summarized and display in a form that is easily understood.

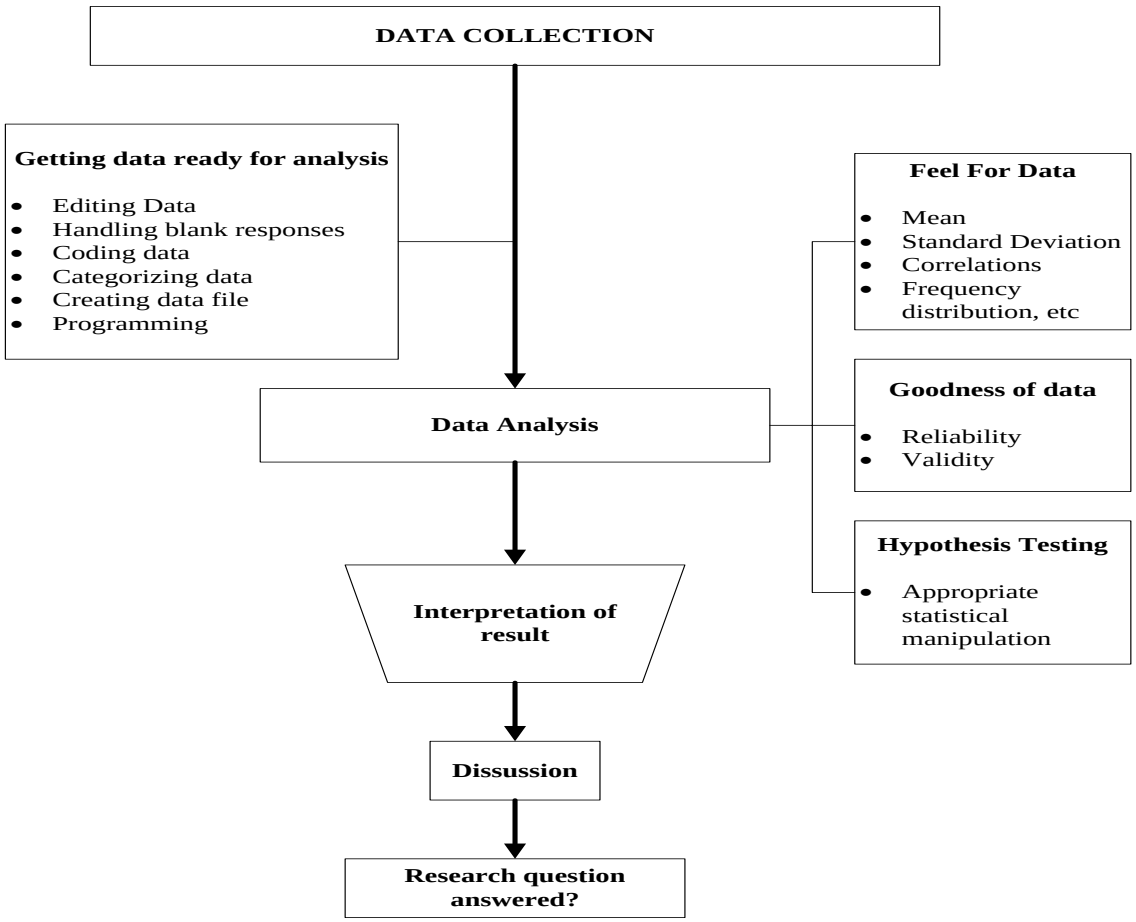

Figure 1. Data analysis flow Chart

4. Results

As of date July 2011, total ISO 14001 certified companies in whole Malaysia are 420 companies in total. Only companies located in Selangor, Kuala Lumpur, Negeri Sembilan, Melaka, Johor, Kedah, Pulau Pinang, and Perak are selected. This is because the ISO certified company from others states mostly come from a government agency and plantation industries. From 290 companies located in these 8 states, only 140 companies were selected as sample size. The other 150 companies were excluded from the survey because they are from plantation industry, construction industry and government agency.

Questionnaires are distributed to the selected company by mail except for a company in Melaka and Negeri Sembilan because most of the questionnaires were delivered by hand. From this 140 ISO 14001 certified companies, only 34.3% or 48 respondent response and return back the questionnaires show as Table 1. According to Sekaran (2010), a 30 percent response rate is considered acceptable because the return rates of mail questionnaires are typically low. In the rules of thumb, sample size larger than 30 and less than 500 is also appropriate for most research (Roscoe, 1975).

State	Frequency	Percent %	Manufacture		Service	
			Frequency	Percent %	Frequency	Percent %
Selangor	7	14.6	4	57.1	3	42.9
Negeri Sembilan	11	22.9	11	100	0	0
Melaka	18	37.5	14	77.8	4	22.2
Johor	5	10.4	4	80	1	20
Kedah	1	2.1	1	100	0	0
Pulau Pinang	5	10.4	5	100	0	0
Perak	1	2.1	1	100	0	0
Total	**48**	**100**	**40**	**83.3**	**8**	**16.7**

Table 1. Distribution of respondent based on State and Industry

4.1. Lean Production Practices in the ISO 14001 Certified Companies

The lean production practices are identified in the ISO 14001 certified companies. This section also will measure the adoption of lean production practices in the ISO 14001 companies. Reliability Test and Descriptive Statistics are discussed in this section. This section will discuss the result from analysis to prove that the ISO 14001 certified companies has adopted lean production practices.

Reliability

Cronbach's alpha is used to assess the inter-item reliability, with alpha values of 0.7 or higher considered to indicate acceptable reliability for establishing scales (Soriano-Meier & Forrester, 2002). Cronbach's alpha is based on the average correlation of items within a test if the items are standardized (Coakes, 2005). Table 2 shows that the alpha value for the ISO 14001 certified company that has adopted lean production practices is 0.772 and no of item is 8, which is exceeded or higher than 0.70.

Other than that, with the exception of Cellular Manufacturing, the scale reliabilities are highest when all the 8 items are included which is 0.809. The alpha value just slightly increased approximately 4.8% of the increment, even after elimination of the item Cellular Manufacturing.

Similar to the study done by Puvanasvaran et al., (2009) on Lean Process, the results show that the alpha value just increased slightly in their studies and no elimination has been done. Therefore the elimination needs not necessarily to be justified (Grandzol & Gershon, 1998).

Scale	Mean	SD	Alpha if Deleted
Lean Production Practices (Alpha = 0.772)			-
Items			
Continuous Improvement (Kaizen)	1.94	0.24	0.758
Zero Defect	1.81	0.39	0.723
Just-In-Time (JIT)	1.9	0.31	0.741
5S' and General Visual Management	1.88	0.33	0.747
Total Preventive Maintenance (TPM)	1.79	0.41	0.72
Pull Production and Kanban	1.69	0.47	0.719
Standardized Work	1.88	0.33	0.747
Cellular Manufacturing	1.63	0.49	0.809

Table 2. Reliability analyses of Lean Production Practices

Descriptive Statistics

Descriptive Statistics of lean production practices are shown in Table 3. It shows that the highest lean production practices in the ISO 14001 certified company are Continuous Improvement (Kaizen). 93.8% or 45 respondents have adopted Continuous Improvement (Kaizen) in their companies. This is followed by Just-In-Time that is 89.6% or 43 respondents. 5S' and General Visual Management and Standardized Work have the same value that is 87.5% or 42 respondents. It follows by Zero Defect that is 81.3% or 39 respondents. Other than that, 79.2% or 38 respondents have adopted Total Preventive Maintenance (TPM) in the companies. It is followed by Pull Production and Kanban that is 68.8% or 33 respondents. The last lean production practice is Cellular Manufacturing that is 62.5% or 30 respondents.

Items		Frequency	Percent	Cumulative Percent	Mean	SD
Continuous Improvement (Kaizen)	No Adoption	3	6.3	6.3	1.94	0.24
	Adoption	45	93.8	100		
Zero Defect	No Adoption	9	18.8	18.8	1.81	0.39
	Adoption	39	81.3	100		
Just-In-Time (JIT)	No Adoption	5	10.4	10.4	1.9	0.31
	Adoption	43	89.6	100		
5S' and General Visual Management	No Adoption	6	12.5	12.5	1.88	0.33
	Adoption	42	87.5	100		
Total Preventive Maintenance (TPM)	No Adoption	10	20.8	20.8	1.79	0.41
	Adoption	38	79.2	100		
Pull Production and Kanban	No Adoption	15	31.3	31.3	1.69	0.47
	Adoption	33	68.8	100		
Standardized Work	No Adoption	6	12.5	12.5	1.88	0.33
	Adoption	42	87.5	100		
Cellular Manufacturing	No Adoption	18	37.5	37.5	1.63	0.49
	Adoption	30	62.5	100		

Table 3. Descriptive Statistics of Lean Production Practices

N	Valid	48
	Missing	0
Mean		1.81
Median		1.94
Mode		2
Std. Deviation		.236
Percentiles	25	1.63
	50	1.94
	75	2.00

Table 4. Mean, Median, and Mode for All Lean Practices

From Table 4, the statistics show that the lean production practices had the mode value of 2. It shows that ISO 14001 companies have adopted the lean principles in their organization. The mean value of 1.81 also shows that the result is more toward to the adoption of lean production practices.

Similar from the previous study, value of the Mean and Standard Deviation is used to analyse the result (Roslan, Taib & Watee, 2009). Similar to the study done by Puvanasvaran, Tay, Megat, Tang and Rosnah (2009), Mean and Standard Deviation was used to identify the degree of adoption in the analysis. Other than that, alpha values of 0.7 or higher considered to indicate acceptable reliability for establishing scales (Soriano-Meier & Forrester, 2002). In the study done by Najmuddin et al., (2009) Descriptive Statistical analysis was used for the study to analyse the result. Result of reliability analysis and descriptive statistic in the Table 2 till Table 4 clearly support that the ISO 14001 certified companies has adopted lean production practices.

4.2. Relationship of lean principles with ISO 14001 requirement

This section will measure the agreement of adoption of lean principles and ISO 14001 (EMS) implementation. Reliability Test and correlation are discussed in this section. This section will discuss the result from analysis to prove that Lean Principles have a positive and significant relationship with the ISO 14001 requirement.

Reliability

The result of reliability analysis for each set of lean principles; value, value streams, flow, pull, and perfection are shown in Table 5. Cronbach's alpha is used to assess the internal consistency reliability of several items or scores that the researcher wants to add together to get a summary or summated scale score (Morgan et al., 2004). In addition, the mean and standard deviation for each of the items are also indicated. Cronbach's alpha is used to assess the inter-item reliability, with alpha values of 0.7 or higher considered to indicate acceptable reliability for establishing scales (Soriano-Meier & Forrester, 2002).

Items	Cronbach's Alpha
Lean Principles	0.986
Value	0.963
Value Streams	0.946
Flow	0.967
Pull	0.955
Perfection	0.945

Table 5. Overall lean principles Cronbach's Alpha

From the result, Table 5 shows that Cronbach's Alpha for first lean principle Value has the alpha value at 0.963. For the second lean principle, Value Stream has the alpha value at 0.946. Flow, the third principle has the alpha value at 0.967. The alpha value of Pull is 0.955 and lastly the alpha value for Perfection is 0.945. All the alpha value for each lean principle is higher than 0.70 and the overall Lean Principles Cronbach's Alpha value is 0.986. George & Mallery (2003: pp. 231) provide the following rules of thumb:

> 0.9 – Excellent,

> 0.8 – Good,

> 0.7 – Acceptable,

> 0.6 – Questionable,

> 0.5 – Poor, and

< 0.5 – Unacceptable

That means all questions are highly reliable with the study. Therefore, it is concluded that the measured have an acceptable level of reliability.

Correlation

This section will discuss the analysis and result of correlation on lean principles with ISO 14001. Each of the lean principles will be identified and studied to measure how strong and significant the correlation is. Lean Principles have a positive and significant relationship with ISO 14001 requirement can be analysed and support from the result in this section.

According to our survey shows that the inter-correlation between 1st lean principle Value with ISO 14001 requirements are highly significant where p is less than 0.01. All five variables were positively correlated with Value. According to the correlation analysis between 1st lean principles Value and ISO 14001 requirements (Table 6), we discover that the higher variable with value are implement documented environmental objectives and targets has the highest correlation, where value r is equal to 0.948. Figure 2 shows the PP plots of Lean Principles "Value" against ISO 14001 Requirements. The PP plot is useful to compare the centre of the

distribution. In this case, we can quite reasonably conclude that the normal distribution provides a good model for the data.

According to Womack and Jones (2003), lean Value is specified from the perspective of the customer. It is about listening to the voice of the customer in order to meet the customer requirements and recognizing and eliminating waste. The understanding of Value from the customer's perspective then carefully to take the time to actually explore this with the customers so that inaccurate assumptions will not be made (Womack & Jones, 2003). Performance indicators can be used to track progress in achieving the objectives and targets as the documentation and communication of objectives and targets improves an organization's ability to achieve its objectives and target (EMS ISO 14004:2004 Requirements with Guidelines – 4.3.3.1). This is where Value shall establish, implement and maintain documented environmental objective and targets as from the customer perspective consistent with the environmental policy and to continual improvement.

Items	1th Lean Principles Value Correlation
Value help to improve our fulfillment to customer requirements in ISO 14001	.935**
Value help to implement documented environmental objectives and targets	.948**
Value help to implement program for achieving environmental objectives and target.	.929**
Value helps an organization comply with environmental laws and regulations.	.938**
Value help to increase awareness and participation of employees.	.923**

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6. Value with ISO 14001 Requirements

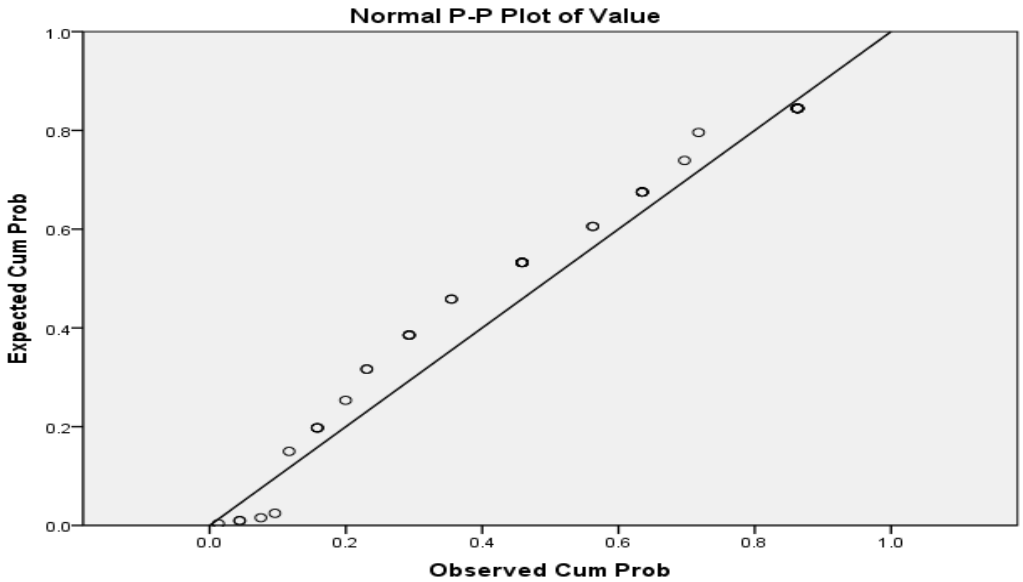

Figure 2. Lean Principles "Value" against ISO 14001 Requirements

From the correlation analysis between 2nd lean principles Value Stream and ISO 14001 requirements (Table 7) are highly significant where p is less than 0.01. We can see that, the higher variable with value stream are identified ISO14001 implementation process loopholes has the highest correlation, where value r is equal to 0.959. Figure 3 shows the PP plots of Lean Principles "Value Stream" against ISO 14001 Requirements. The normal probability plot shows a strongly linear pattern. There are only minor deviations from the line fit to the points on the probability plot. The normal distribution appears to be a good model for these data.

Value Stream will recognize waste or non value added step in the process and is known as Value Stream Mapping (Womack & Jones, 2003). The organization shall establish, document, implement, maintain, and continually improve an environmental management system in accordance with the requirements of the international standard and determine how to fulfil the requirement (EMS ISO 14001:2004 Requirements – 4.1). This where Value stream helps to identify ISO 14001 implementation process loopholes. Value Stream Mapping will identify all the steps in the value stream for each process by eliminating whenever possible the steps that do not create value and continuous improvement.

Items	2nd Lean Principles Value Stream Correlation
Value stream help to streamline work in ISO14001 implementation.	.872**
Value stream significantly reduce waste within ISO 14001 implementation process.	.907**
Value stream help to identify ISO14001 implementation process loopholes.	.959**
Value stream help to identify actual and potential nonconformity.	.909**
Value stream help to reduce the complex documents control system in ISO 14001 implementation.	.896**

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7. Value Stream with ISO 14001 Requirements

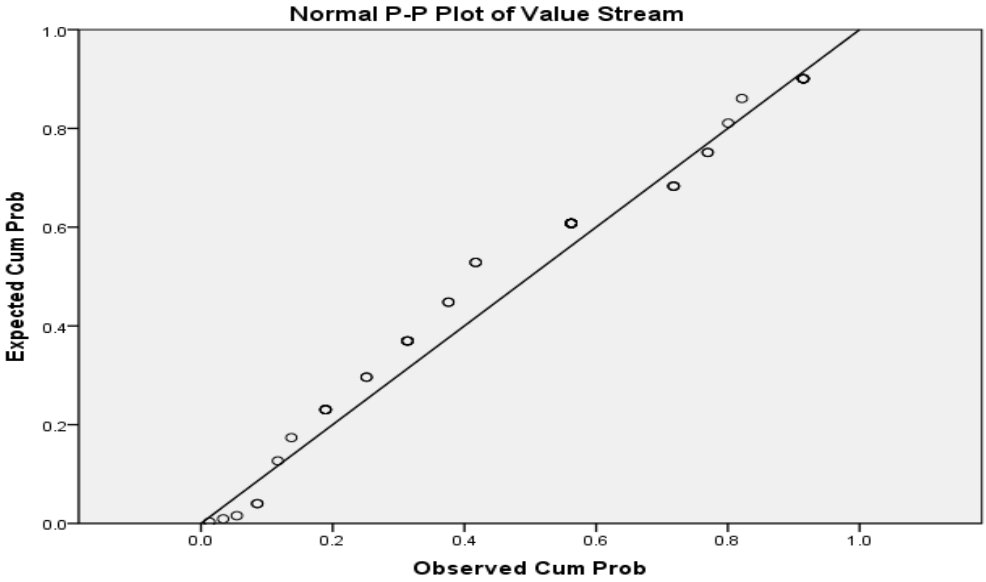

Figure 3. Lean Principles "Value Stream" against ISO 14001 Requirements

Based on the relationship between 3rd lean principles Flow and ISO 14001 requirements (Table 8) are highly significant where p is less than 0.01. All six variables were positively correlated with Flow, we find that identifying nonconformity to mitigate their environmental impacts has the highest correlation, where value r is equal to 0.961. Figure 4 shows the PP plots of Lean Principles "Flow" against ISO 14001 Requirements. The normal probability plot shows a reasonably linear pattern in the centre of the data. However, the tails, particularly the lower tail, show departures from the fitted line. A distribution other than the normal distribution would be a good model for these data.

Items	3rd Lean Principles Flow Correlation
Flow help to identifying nonconformity to mitigate their environmental impacts.	.961**
Flow help to correcting nonconformity to mitigate their environmental impacts.	.951**
Flow help to investigating nonconformity in order to avoid their recurrence.	.885**
Flow help to evaluating the need for actions to prevent nonconformity to avoid their occurrence.	.927**
Flow help to reduce the usage of resources in ISO 14001 implementation.	.885**
Flow help the organization to verify that the system is operating according to plan.	.958**

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8. Flow with ISO 14001 Requirements

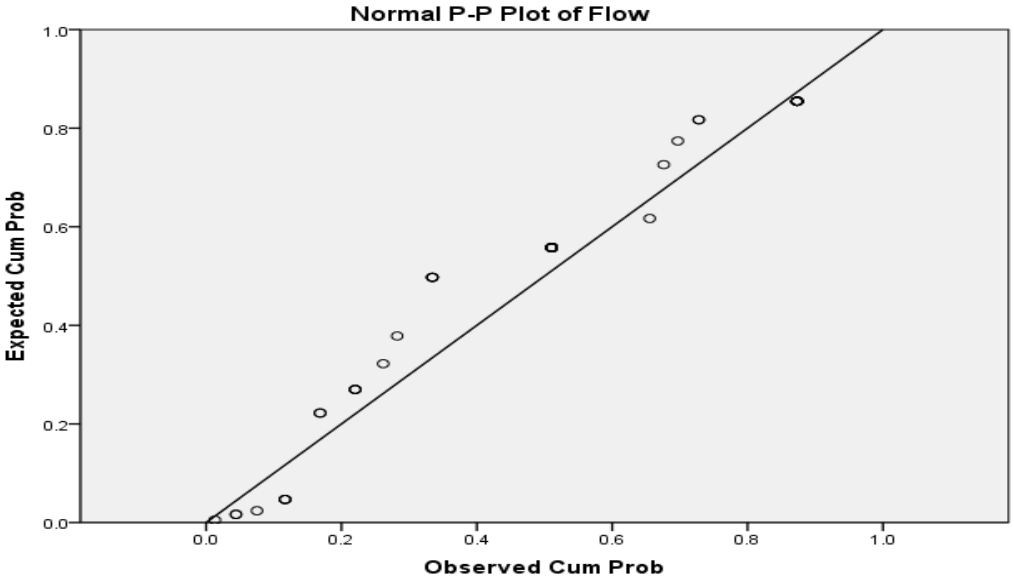

Figure 4. Lean Principles "Flow" against ISO 14001 Requirements

According to Womack and Jones (2003), Flow is about working towards a process that delivers value with the most effective use of resources. EMS has to be effective on an ongoing basis so organisations should have a systematic method for identifying actual and potential nonconformity, making corrections and taking corrective and preventive action (EMS ISO 14004:2004 Requirements with Guidelines – 4.5.3). This where Flow will come in to identifying

nonconformity to mitigate the environmental impacts as flow makes the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.

According to our survey shows that the inter-correlation between 4th lean principle Pull with ISO 14001 requirements are highly significant where p is less than 0.01. All four variables were positively correlated with Pull. From the Table 9, the correlation between lean principle Pull and ISO 14001 Requirement, the organization stipulating the operating criteria in the procedures has the highest correlation, where value r is equal to 0.950. Figure 5 shows the PP plots of Lean Principles "Pull" against ISO 14001 Requirements. For data with long tails relative to the normal distribution, the non linearity of the normal probability plot shows the middle of the data may show an S-like pattern. In this particular case, the S pattern in the middle is fairly mild. In this case we can reasonably conclude that the normal distribution can be improved upon as a model for these data.

Womack & Jones (2003), Pull is to get close as they can to produce according to demand or consumption rate with little or no inventory in the system. From the EMS ISO 14004:2004 Requirements with Guidelines – 4.4.6, an organization needs to apply some type of operational controls to meet its environmental policy commitments, achieve its objectives and targets, comply with applicable legal requirements and other requirements to which the organization subscribes and manage its significant environmental aspects. This is where Pull can help the organization stipulating the operating criteria in the procedures as Pull can produce to demand and link the process closer to actual customer demand with little or no inventory in the systems.

Items	4th Lean Principles Pull Correlation
Pull help to taking actions to mitigate their environmental impacts.	.938**
Pull help to implementing appropriate actions designed to avoid nonconformity occurrence.	.933**
Pull help the organization to ensure the effective planning that relate to its significant environmental aspects.	.936**
Pull help the organization stipulating the operating criteria in the procedures.	.950**

**. Correlation is significant at the 0.01 level (2-tailed).

Table 9. Pull with ISO 14001 Requirements

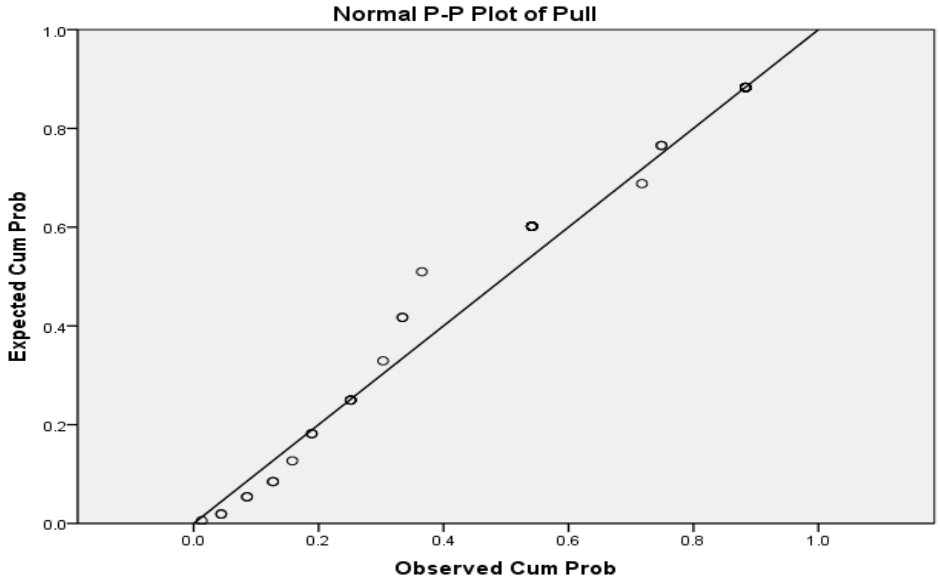

Figure 5. Lean Principles "Pull" against ISO 14001 Requirements

Table 10 shows that the inter-correlation between 5th lean principle Perfection with ISO 14001 requirements. All four variables were positively correlated with lean principle Perfection highly significant where p is less than 0.01. From the table, correlation between lean principle Perfection and ISO 14001 requirement, to ensure this standard continuing suitability, adequacy and effectiveness has the highest correlation, where value r is equal to 0.960. Figure 6 shows the PP plots of Lean Principles "Perfection" against ISO 14001 Requirements. There are only minor deviations from the line fit to the points on the probability plot. The normal distribution appears to be a good model for these data.

Perfection is about the continuing striving for the perfect process by continually removing successive layers of waste as it was uncovered (Womack & Jones, 2003). An organization should periodically review and continually improve its environmental management system with the objective of improving its overall environmental performance (EMS ISO 14004:2004 Requirements with Guidelines – 4.5.3). With Perfection it can help to ensure the standard continuing suitability, adequacy and effectiveness of the ISO 14001.

Items	5th Lean Principles Perfection Correlation
Perfection helps to assessing opportunities for improvement and the need for changes to the standard.	.922**
Perfection helps to ensure this standard continuing suitability, adequacy and effectiveness.	.960**
Perfection helps to ensure this standard consistent with the commitment to continual improvement.	.879**
Perfection helps in sustaining the ISO 14001 standards certification.	.949**

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10. Perfection with ISO 14001 Requirements

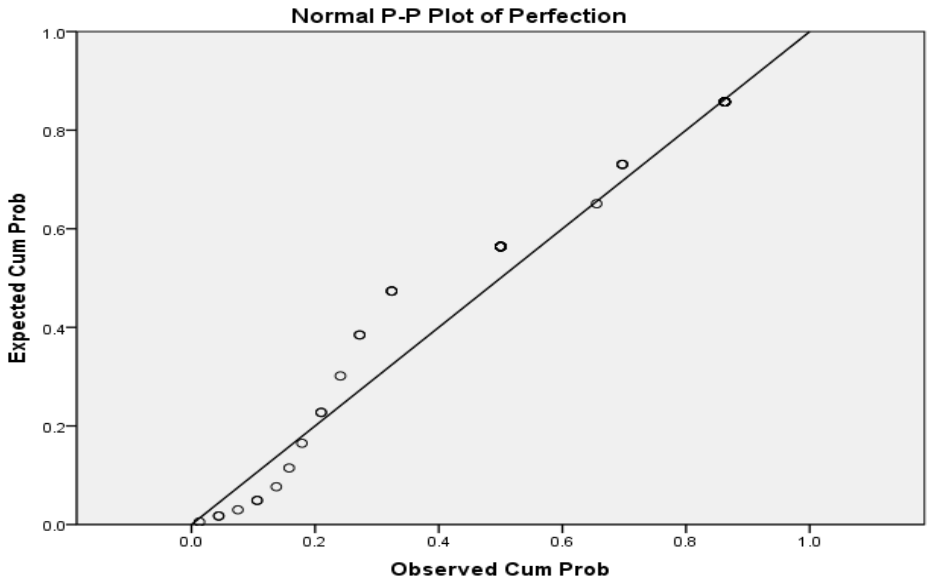

Figure 6. Lean Principles "Perfection" against ISO 14001 Requirements

5. Discussion

The results of the data analyses show that all ISO 14001 companies do adopt at least one of lean production practices. Other than that, the result of reliability analysis in the Table 2 show that all the variables are indicated acceptable reliability for establishing scales with the Cronbach's alpha value which is exceeded or higher than 0.70. While it also shows that each variable of Continuous Improvement (Kaizen), Zero Defect, Just-In-Time (JIT), 5S' and General Visual Management, Total Preventive Maintenance (TPM), Pull Production and Kanban, Standardized Work, and Cellular Manufacturing has the Mean value higher than average toward the adoption of lean production practices. Similar from the previous study, value of the Mean and Standard Deviation is used to analyse the result (Roslan et al., 2009). Similar to the study done by Puvanasvaran (2009), Mean and Standard Deviation was used to identify the degree of adoption in the analysis. Other than that, alpha values of 0.7 or higher considered to indicate acceptable reliability for establishing scales (Soriano-Meier & Forrester, 2002).

This study also found that there was a significant and positive relationship between Lean Principles: value, value stream, flow, pull and perfection with the ISO 14001 requirement. Similar to the study done by Puvanasvaran (2009), Reliability Test and Correlation was used to identify the degree of adoption and commitment in the analysis to support and prove the Hypotheses. Similar to the study done by Roslan et al., (2009), the hypotheses are proved and clarify with the Pearson Correlation Analysis.

Table 5 shows that all the variables are indicate highly acceptable reliability for establishing scales with the Cronbach's Alpha which is exceed or higher than 0.70. The table also shows that the Cronbach's Alpha value of five lean principles that are Value (0.963), Value Streams (0.946), Flow (0.967), Pull (0.955) and Perfection (0.945). The Cronbach's Alpha for lean

principles is 0.986 far exceed 0.70 which mean the established scales reliability is highly acceptable.

Table 6 to Table 10 indicates that all the variables are positively correlated to the lean principles that are Value, Value Streams, Flow, Pull, and Perfection. The Correlation between lean principles and ISO 14001 requirements are highly significant where p value is less than 0.01. As shown in Table 6, correlation between lean principle Flow and ISO 14001 Requirement, to identify nonconformity to mitigate their environmental impacts has the largest correlation, where value r is equal to 0.961.

To use skewness and kurtosis to see if the distribution is normal, we need to convert the given skewness and kurtosis scores to z-scores. Use the following formula: zskewness = (K-0)/SEskewness or z kurtosis = (S-0)/SEkurtosis. S = Skewness; K = kurtosis; SE = Standard Error (of skewness or kurtosis). If the value is smaller than 1.96, the distribution is normal. In larger samples, this value should be increased to 2.58. The results of the Z score of Skewness for lean principles value is -0.478/0.343 = 1.39, value stream is -0.739/0.343 = 2.15, flow is -0.471/0.343 = 1.37, pull is -0.378/0.343 = 1.10 and perfection -0.477/0.343 = 1.39. The results show the Z score for the five lean principles is smaller than 1.96, the distribution is normal. Another way in which normality can be tested is by means of the Kolmogorov-Smirnov (K-S) and the Shapiro-Wilk tests. These tests compare the distribution with a comparable normal distribution. The Shapiro-Wilk test is used for small sample sizes (less than 50). The results of the tests are shown in Table 11. Shapiro-Wilk test for Lean principles value p= 0.053, value stream p= 0.056, Flow p= 0.052, Pull p=0.072 and perfection p= 0.114. If the Sig p>0.05 and therefore the data is normally distributed. From these result we reach the conclusion that lean principles has a positive relationship with ISO 14001 requirements.

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Value	.124	48	.062	.953	48	.053
Value Stream	.126	48	.055	.952	48	.056
Flow	.125	48	.059	.937	48	.052
Pull	.127	48	.051	.956	48	.072
Perfection	.125	48	.060	.961	48	.114

(a) Lilliefors Significance Correction

Table 11. Output of Kolmogorov-Smirnov and Shapiro-Wilk Test for Checking the Normality of the Lean Principles

6. Conclusion

The purpose of this paper is to identify the ISO 14001 certifies companies adopted the lean production practices and to measure the positive and significant relationship of lean principles with the ISO 14001 requirement. The results show that all ISO 14001 companies do adopt at

least one lean production practices. Primarily, the main findings show that the lean principles have positive and highly significant relationship with ISO 14001 requirements.

There is a need for everyone to be aware and understand the lean principles and the process of implementation. This is where it plays a crucial role in ensuring the successful implementation of lean principles integrates with ISO14001 requirements. This is because the integration of lean principles in ISO 14001 will serve practical methods for ISO14001 EMS to achieve the continual improvement.

There are still some limitations in the research. Firstly, the research mainly focuses on the manufacturing environment and services industry. Secondly, the research can be further enhanced through a bigger population with various types of industries to understand the adoption of lean principles in ISO14001 implementation.

6.1. Recommendations and future study

This is one of the first attempts to understand and integrate the lean principles into ISO 14001. Based on the current situation, there is no integration within this two management system. The integration of lean principles into ISO 14001 will serve practical methods for this standard to achieve the continual improvement.

There are few interesting recommendations and future study that can be done in the future. They are:

- will become another interesting area for future study would be to understand the impacts of lean principles on ISO 14001. The first is related to the so called environmental management system and the second is to the five lean principles.
- lean principles and ISO 14001 have natural coexistence whether people understand the relationship or not. As the study to understand the correlation between lean principles and ISO 14001, future study can better integrate both and upgrade the organization or company in terms of efficiency as well as continuous improvement of the ISO 14001.
- once the linkage has been analysed and identified, the development of the framework can be done in the future study. With this framework, the study can be implemented in the ISO 14001 certified companies in Malaysia and the success of the lean principles and ISO 14001 integration can be measured.
- from this measurement and study, more improvement can be done with the framework and implementation process before the integration of lean principles and ISO 14001 can be truly a success.

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