Legend:

- Strong positive relationship;
- Moderate positive relationship; and,
- Weak positive relationship

Strong positive relationships are evident in Strive for Perfection aspect of Lean Production such as its association with TQM's Top Management Commitment (r=0.665), Continuous Improvement (r=0.751), Product Innovation (r=0.711), Employee Involvement (r=0.771), and Education & Training (r=0.671). The strong positive relationship between Continuous Improvement and Strive for Perfection is a practical implication that for a company to strive towards excellence, it has to embrace continuous improvement. Another insight from the result is that Employee Involvement and Education & Training may steer the companies towards continuous improvement and operational excellence. On the other hand, a strong Top Management Commitment may yield to a strong culture of continuous improvement and operational excellence.

A strong positive relationship between Product Innovation and Strive for Perfection (r=0.711) would also indicate that a strong cross-functional participation in the review of customer requirements and product realization at the design stage may facilitate Strive for Perfection in various ways. For example, updating operations procedures and work instructions at the mass production stage would be easier since the involvement of the process owners at the design stage enables them to translate the design requirements in a continuous improvement perspective.

A strong positive relationship is also observed between Continuous Improvement and Value Stream (r=0.687) as well as Employee Involvement and Value Stream (r=0.693). This would imply that to understand and improve the Value Stream in a Lean Production setting, managers may need to incorporate this in continuous improvement activities while involving employees. This result could also lead to an insight that Value Stream should not be done in a top-down perspective, rather in a more participative continuous improvement environment.

Surprisingly, Product Innovation and Flow (r=0.655) also manifested a strong positive relationship. Contextually, this would imply that when customer requirements, cross-functional participation and quality considerations are diligently implemented at product innovation stage, the transition to production would be smooth and thus, the requirements for a continuous flow would be considered as well.

While some aspects of TQM demonstrated a strong positive relationship with some aspects of Lean Production, some aspects also demonstrated a weak positive relationship. Weak positive relationship is demonstrated by the Supplier Quality Management aspect of TQM with LP's Value (r=0.345), Value Stream (r=0.399) and Pull (r=0.389) aspects of Lean Production. The weak positive relationship between Supplier Quality Management and Value would imply a challenge that management need to consider how customer value can be more directly linked in managing suppliers. This weak positive relationship would call the need for managers to look at end-to-end linkage of customer requirement and product or service realization from suppliers in a TQM and Lean Production environment. In a value stream and pull production perspective, this result would manifest a weak linkage of key suppliers to add value to the organization in terms of quality, cost and delivery. This may be accounted to the weak relationship of the companies with key suppliers, which may result to cooperation and coordination issues in implementing just-in-time (JIT) system and quality improvement with suppliers. Rewards and Recognition and Pull also demonstrated a weak positive relationship (r=0.368). This weak linkage would imply that employees may not be motivated well to prove efficiency in their tasks because they may not be rewarded and recognized accordingly.

Looking at the heat map presented in table 1, weak positive relationships are mainly demonstrated by three aspects: Supplier Quality Management, Benchmarking and Pull. This would imply that managers may need to focus more on these three aspects when simultaneously implementing TQM and LP as one integrated program. In the case of Supplier Quality Management, for example, its weak relationship with most of the Lean aspects may be attributed to lack of coordination and information sharing on how key suppliers can contribute to customer value and efficiency of the company's internal processes. One reason may be attributed to the greater preference of companies to reduce prices from supplier purchases than establishing a long-term relationship with suppliers. This situation would perceive by suppliers as "adversarial". As such, they may not initiate or cooperate towards a collaborative and mutually beneficial activities such as just-in-time systems and joint improvement programs.

In the case of Benchmarking, the weak relationship with most of the LP aspects would be due to low level of implementation compared to other TQM aspects. To strongly associate Benchmarking with Value Stream, Flow and Pull, managers may need to benchmark TQM and LP practices externally and demonstrate the benefits of benchmarking both strategies as the best practices are customized and applied internally. After which, internal sharing of TQM and LP best practices may be reinforced to strengthen the benchmarking culture of the company.

Pull is the aspect in LP with the majority of weak positive relationship with TQM aspects. Weak association is observed with its relationship with TQM the following TQM aspects: Top Management Commitment, Supplier Quality Management, Benchmarking, Reward and Recognition and Education and Training. The weak positive relationship of Pull with these TQM aspects may be due to tool- and efficiency-specific nature of Pull which may not be directly covered by the said TQM aspects. For example, Pull is specific to just-in-time systems, use of Kanban tools and inventory control mechanisms where the items of the mentioned TQM aspects may not be directly linked to these Pull implementations. Another reason may be attributed to low extent of Pull implementation compared to other LP aspects. This would manifest that LP aspect implementation may need to be improved by looking at how it should be "specifically" integrated with other TQM aspects. This may be started by leveraging on the moderate positive relationship of Pull with other TQM aspects such as Continuous Improvement, Product Innovation, Employee Involvement and Customer Focus.

Looking at the heat map in a strong positive relationship perspective, it is evident that TQM's Continuous Improvement and LP's Strive for Perfection demonstrated the most numbers of strongest association compared with other aspects. This would imply that strongly implementing Continuous Improvement and Strive for Perfection items would sustain the implementation of overall TQM and LP. Companies may also use these two aspects as venue to improve the other aspects.

Overall, majority of the relationship of each TQM aspects with each LP aspects demonstrated a moderate positive relationship. This result is also relative to the overall implementation of TQM and LP which is moderate extent of implementation. This would imply that companies may still need strive on improving the implementation of TQM and LP towards a more integrated program.

3.2 Each TQM Construct and Overall Lean Production

Generally, the aspects of TQM showed a moderate positive and significant correlation with overall Lean Production as shown in Table 2.

Table 2. Pearson correlation of TQM constructs and overall Lean Production

TQM Construct	Pearson Correlation with Lean Overall
Top Management Commitment	.669**
Supplier Quality Management	.525**
Continuous Improvement	.780**
Product Innovation	.748**
Benchmarking	.535**
Employee Involvement	.789**
Reward and Recognition	.585**
Education and Training	.659**
Customer Focus	.662**
**. Correlation is significant at the 0.01 level (2-tailed).	

Legend:
- Strong positive relationship;
- Moderate positive relationship; and,
- Weak positive relationship

Majority of the "soft aspects" such as Top Management Commitment, Employee Involvement, Reward and Recognition, and Education and Training showed a positive significant relationship with Lean Production which is supported the findings of Khalili, et al. (2018). Employee Involvement (r=0.789), Continuous Improvement (r=0.780) and Product Innovation (r=0.748) are the top TQM aspects with strong positive relationship to overall Lean Production. This would imply that strong implementation of these three aspects may be used as company leverage in a successful implementation of Lean Production.

Supplier Quality Management (r=0.525) demonstrated a moderate positive relationship with overall Lean Production. This would imply that the improvement efforts of the company in managing suppliers may not directly improve Lean Production implementation as much as other TQM aspects. As suggested by Kim (2015), the integration of Lean Production to supplier can be enhanced through a focused implementation on what Lean aspects can be implemented to suppliers and intertwined onsite. In order to improve this, as previously evident on the studies of Friedli, et al. (2010) manufacturing companies should ensure the end-to-end consideration of the value chain through the management of the downstream interface to customers. This finding would be an improvement in the electronics and semiconductor industry as it is widely recognized that supplier relationships provide a vital link in the implementation of successful Just-in-time (JIT) systems through a win-win outcome. This can be achieved through appropriate supplier selection and effective supplier relationship management (Aksoy & Ozturk, 2011).

Benchmarking and Rewards and Recognition also showed a moderate positive relationship with overal LP. This weaker relationship is also aligned with the lower extent of implemenation of both TQM aspects as explained in the previous sections of this chapter.

Looking at the heat map, majority of the TQM aspects (6 out 9) have a strong positive relationship with overall LP, while the rest of the items have a moderate positive relationship. This would imply that TQM aspects can be strongly aligned with overall LP. As such, there should be a minimum conflict when implementing both operational strategies simultaneously.

3.3 Overall TQM and Overall Lean Production

Overall, TQM and Lean Production have a strong positive linear and significant relationship as shown in Table 3.

Table 3. Pearson correlation of TQM and Lean Production

--	--	LEAN Overall
TQM Overall	Pearson Correlation	.838**
	Sig. (2-tailed)	.000
	N	110

This strong and significant relationship implies that the association of the two operational practices is evident. As such, in an implementation perspective, the improved implementation of TQM can reflect a corresponding improvement in Lean Production implementation. Also, this would imply that companies that are already implementing a robust TQM may implement Lean Production easily.

4. Summary of Findings and Conclusion

Overall, the relationship of TQM and LP is significant and strong positive. However, when the relationships are compared at TQM aspect level to overall LP and LP aspect level, the extent of relationship varies from one aspect to another. At the aspect level, TQM aspects with the strongest relationship with LP aspects are: Continuous Improvement, Product Innovation and Employee Involvement. On the other hand, TQM aspects with the weakest relationship with LP are: Supplier Quality Management and Benchmarking. Strive for Perfection aspect of LP demonstrated the strongest relationship with TQM aspects. Value Stream and Pull demonstrated the weakest relationship with TQM aspects.

Continuous improvement and striving for perfection strongly bind TQM and LP when they are simultaneously implemented. This is further reinforced through cross-functional teams, quality circles and facilitation of a suggestion system. Thus, improving employee involvement and commitment to further steer continuous improvement activities.

Benchmarking, supplier quality management and pull production do not strongly support the association of TQM and LP. This can be attributed to the lower extent of their implementation, indirect linkage with other aspects and the specific nature of the aspects. The dependence of pull production and JIT system to supplier quality management strongly supports this finding. The lower extent of implementing and prioritizing long-term supplier relationships would have impacted the implementation of JIT system in the companies.

5. Implication of the Study

The results of this study have implications for the potential integration of TQM and LP as one program in manufacturing environments. By having an insight on the detailed and holistic extent of relationship between TQM and LP, a comprehensive simultaneous implementation program can be developed with embedded continuous improvement techniques. Thus, a minimized effort and resources with a higher managerial success may be demonstrated while managing two operational strategies at the same time.

The results of this study also indicate that describing the relationship between two variables using specific to general analysis is beneficial to understand the association. In a methodology perspective, this study has forwarded that looking the relationship at the aspect or construct level can provide insight on how the elements of a concept being analyzed "behave" towards a systematic and holistic relationship. Focusing not only on the absolute description of an element or a dimension but also on relative description can also provide insight on the comparative impact towards a systematic conclusion and recommendation.

The results of this study also have empirical implications. The validity and reliability of the developed LP instrument in this study proved that Womack and Jones's framework (the 5 principles of Lean) is empirically valid and that this can be used as instrument for Lean measures in survey studies. This proof may also provide further confidence to industrial consultants and practitioners on the applicability of the Lean framework as the forefront in developing, implementing and sustaining Lean practices. Another implication is the establishment of the significant relationship between TQM and LP which empirically validated the interrelatedness of TQM and LP.

This study also forwarded information on the gaps (weak items and aspects), constraints (weak relationships) and difference in the implementation of TQM and LP. As an implication, companies may need to focus on these aspects in a continuous improvement perspective. On the other hand, this study also forwarded on which aspects companies may need to use as leverage (strong items, aspects and relationships) to successfully implement TQM and LP.

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Biography

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