Lean Transformation Sustainability Models: A Critical Review

Azim Azuan Osman[1], Rusalbiah Che Mamat[2] and Mazita Mat Ali[3]

[1]School of Technology Management and Logistics, Universiti Utara Malaysia Main Campus,
Sintok, Kedah 06010, Malaysia
azim_azuan@oyagsb.uum.edu.my

[23]Department of Technology and Supply Chain Management, Universiti Teknologi MARA Puncak Alam Campus,
Kuala Selangor, Selangor 42300, Malaysia
rusal514@uitm.edu.my

[1]Department of Electrical Engineering, Politeknik Sultan Abdul Halim Mu'adzam Shah,
Jitra, Kedah 06000, Malaysia
mazita@polimas.edu.my

Received: 2 September 2020 Revised from: 25 September 2020 Accepted:25 October 2020
Published: 31 October 2020

Abstract

Transformation from conventional production system to lean production system has helped many manufacturing companies to reduce cost and ultimately improve their business performance. Unfortunately, there were also many reported cases where manufacturers failed to sustain the transformation until they achieve the ultimate result. Therefore, this article aimed to review existing Lean Transformation Sustainability (LTS) models that might help scholars and practitioners gain better insights on how to sustain lean transformation. This article compiled 37 LTS models through assistance of online bibliographic databases. The review study found that many researchers have proposed original models which involved high participation of practitioners and to some extent consultants in the development of LTS models. It was also found that a huge number of inconsistent elements were used to propose the LTS models. The study findings provided direction towards future research opportunities such as the development of LTS assessment model that encompassed standard set of elements for generalisation.

Keywords: Lean Transformation, Lean Sustainability, Lean Maturity, Sustainable Change, Framework.

1. Introduction

Lean production system is a production improvement model that concentrates on eliminating wastes and continuous improvement activities (Abdul Wahab, Mukhtar, & Sulaiman, 2017). Wastes in production system can be classified into eight types, known by the acronym of DOWNTIME (i.e. Defects, Overproduction, Waiting times, Non-utilised talents, Transportations, Inventories, Motions, and Excess processings). These wastes are inevitable when conventional production systems such as mass production system and batch-and-queue production system are used. Thus, resulting in the elevation of cost consumption, delivery tardiness, and workers' frustration which are bad for business (Emiliani, 2016; Kilpatrick, 2003). As such, manufacturing companies around the globe began to employ lean transformation. Lean

transformation means the conversion from conventional manufacturing systems to lean production system (Mann, 2015; Roth, 2011).

However, such transformation often last for just a short period before manufacturing companies can acquire the ultimate advantage of lean production system (Lean Learning Center, 2008; Pentlicki, 2014; Veech, 2004). In response to this issue, many lean scholars had taken initiative to propose and develop models and frameworks on how to sustain lean transformation for manufacturing companies. Nevertheless, academic journal that compile and critically review existing lean transformation sustainability models is still absent. Therefore, this article provides a critical review on lean transformation sustainability models and frameworks and highlights future research opportunities for lean scholars as well as enlighten lean practitioners regarding this topic of interest.

2. Literature Review

This literature review section was organized in two sub-sections; (1) review on lean transformation sustainability definitions, and (2) review on distinctions between model and framework.

2.1 About Lean Transformation Sustainability

Lean Transformation Sustainability (LTS) refers to the ability to maintain the momentum of conversion from conventional production systems into lean production system, while achieving persistent performance goals over time (Osman, Othman, & Abdul Rahim, 2020a). In this context, conventional production systems include mass production, batch production and/or queue system (Mann, 2015) and the word ‘sustain’ is synonym to ‘keep up’, ‘maintain’, ‘endure’, ‘preserve’, or ‘continue’ (Kipfer, 2005). Although some studies simply addressed this concept just as ‘Lean Sustainability’, this term often led to confusion with other concept. According to Jørgensen, Matthiesen, Nielsen, and Johansen (2007), the term Lean Sustainability often associated with the concept of integration between lean management and ecological preservation. As such, this article used Lean Transformation Sustainability term to unravel this confusion. Morever, the addition of the word ‘transformation’ clarifies the depth, magnitude, and wholeness of conversion from conventional production system to lean production system (Roth, 2011).

There are also other terms used in previous literatures to express Lean Transformation Sustainability. For example, Alukal (2006) used the term ‘sustainable lean conversion’ and specified it as obtaining enduring success with lean deployment. Meanwhile, Ruffa (2011) described ‘sustainable lean organisation’ as companies that have made to the highest level of lean maturity and advancing at a strong but cautious pace. These companies are marked by their strong, steady value margin across a wide range of conditions. On the other hand, Mohd Yusof and Aoki (2016) characterised ‘sustainable lean companies’ as companies that have achieved a state where adopting practices of costs reduction through waste elimination is the way of life. Although all three definitions are not exactly consistent to one another, they higlights the same essence that refer sustainable lean as progression of lean implementation over time.

2.2 About Models and Frameworks

The terms 'model' and 'framework' are among popular phrases in the field of operations research and often used interchangeably. Nevertheless, a distinction between these two terms could be further discuss. From the perspective of operations research, Mohd Yusof and Aspinwall (2000) asserted that a model answers the question 'what is', whereas, a framework answers the question 'how to'. In the same vein, Osman, Othman, and Abdul Rahim (2020b) perceived a model as a graphical respresentation of statistical assessment on relationship between variables from survey studies, and a framework represent a complete plan of implementation (i.e. roadmap), established usually based on case study method.

However, from the perspective of research methodology scholars, both terms can be concluded as similar. For instance, De Vaus (2002) viewed a model as a theoretical specification of the way in which a set of variables are proposed to be causally related in a scientific research. Meanwhile, Fraenkel, Wallen, and Hyun (2012) viewed a framework as the theoretical approach used to structure a research study. Both definitions highlighted the use of theory as the foundation of conducting a research study. Hence, this review article agreed that both terms (model and framework) can be used interchangeably, but distinction can be made if necessary to suit the purpose of study.

3. Methodology

This review study was designed following four main steps as visualised in Figure 3.1

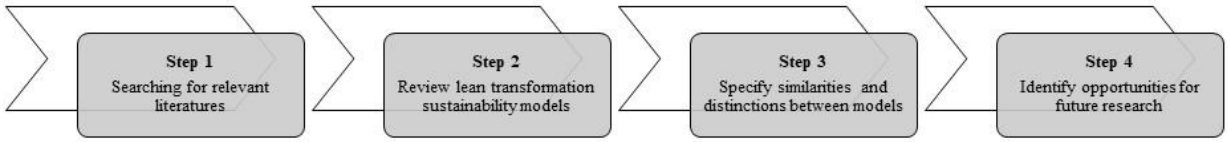


Fig 3.1: Review steps

3.1 Step 1: Searching for relevant literatures

Google Scholar database was used to search for publications relevant to the keyword entries since it provides a broad outreach (Furunes, 2019). Google scholar enable a broad outreach by redirecting user's search to several other journal and publisher databases. Began with keywords including 'lean sustainability', 'sustainable lean', 'sustaining lean', and 'lean maturity' relevant publications were retrieved. These keywords were selected based on terms used in pilot publications referred by the authors (Alukal, 2006; Jørgensen et al., 2007; Mohd Yusof & Aoki, 2016; Ruffa, 2011). These publications provided detailed definitions of LTS concept. In searching for literatures, it is imperative to decide when to stop (Thomé, Scavarda, & Scavarda, 2016). Hence, authors decided to review 37 relevant models that are deemed sufficient to produce a comprehensive review article. In fact, previous review articles on other lean-related models published in top journals only covered 30 models (Gurumurthy & Kodali, 2010; Jasti & Kodali, 2015). Therefore, inclusion of 37 models in this review article can be considered as more than adequate.

3.2 Step 2: Review lean transformation sustainability models

Retrieved publications consisted of indexed journal, peer-review journals, books, and grey publications. Grey publications refers to any literature that are not available in the mainstream publishing and distribution channels, including research reports, working papers, dissertations, thesis, trade and industry magazines (Thomé et al., 2016). In fact, inclusion of grey publications makes a review article more extensive and rigorous (Boell & Cecez-Kecmanovic, 2015). Thus, grey publications especially theses and dissertations were also included in this review study.

3.3 Step 3: Specify similarities and distinctions between models

Following Jasti and Kodali (2015) review study, similarities and distinctions between LTS models were specified in terms of; (1) originality of models, (2) source of the models, (3) model validation, (4) validation mode, and (5) elements in the model. These comparisons were presented in the discussion section of this article. In addition, the illustrations of every LTS model included in this review were labelled from Model 1 to Model 37 following the year of publication and according to alphabetical order of first authors' names (see supplemental document available online at https://www.researchgate.net/publication/344780776_ABRIJ2020_Supplemental_document).

3.4 Step 4: Identify opportunities for future research

Opportunities for future research were recommended based on several research gaps emerged from the comparisons of LTS models. Recommendations for future research were included in the conclusion section of this article.

4. Results and Discussion

4.1 Originality of Models

This comparison was made to find out whether the model is developed based on existing LTS model or not. The model is categorised as a novel model if it is not based on existing LTS model. Otherwise, the proposed model is categorised as an adapted model. This kind of categorisation criterion will help to find out the current trend of theory building in LTS model. If there are higher number of novel models in the literature, it is a clear indication of limited research efforts to generalise the existing LTS models. Whereas, if the trend is otherwise, then it indicates that the research is developed within the restricted boundary.

According to Jasti and Kodali (2015), any operations management research area should require novelty or originality of theory building to prosper it as one of the established research discipline. At the same time, modifying existing theories to suit present day requirements is equally important in developing a coherent theory building in any research area. Hence, this review attempted to analyse the same issue in this sub-section. Table 1 presented the frequency distribution of novel and adapted LTS models.

Table 1: Originality of models

Category	Frequency	Model's Label
Novel	32	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32, 33, 35, 37
Adapted	5	8, 9, 29, 34, 36

Table 1 clearly indicated that 86% of the models fall in the category of novel models. This kind of trend is good for growth of LTS, but at the same time too much of novelty theory building leads to inconsistent focus of research in the field of LTS. Only 14% of the models belonged to the adapted category. Hence, the scholars should give more attention to build theory based on the existing theories (i.e. adapted model) in the future researches.

4.2 Source of the Models

Research models also can be categorised according to researcher's background; (1) academic-based, (2) practitioners-based, (3) consultants-based and, (4) combination-based (Jasti & Kodali, 2015; Mohd Yusof & Aspinwall, 2000). Academic-based model refers to the model developed based on academic research in academic institutions. Meanwhile, models that are developed from the industry implementation procedures can be categorised as practitioners-based models. If the model is proposed based on experience of lean coaches or training experts, then it is labelled consultants-based model. Moreover, possible model combinations include academia and practitioners-based, academia and consultant-based or consultants and practiotioners-based. Combination-based models are usually developed through action research or case study research design. This kind of analysis will help to specify the gap between theory building and practice in the area of LTS research interest. The frequency of models published as academic-, practitioners-consultants-based, and combination-based models is charted in Table 2.

Table 2: Source of the models

Category	Frequency	Model's Label
Academia-based	18	5, 7, 13, 14, 16, 19, 21, 23, 24, 26, 28, 30, 32, 34, 35, 36, 37
Practitioners-based	2	3, 12
Consultants-based	2	1, 15
Academia and practitioners-based	11	2, 6, 8, 11, 17, 18, 22, 25, 29, 31, 33
Academia and consultants-based	3	9, 10, 27
Consultants and practitioners-based	1	21

Table 2 revealed that 49% of the existing LTS models were proposed by academic researchers. The analysis also revealed that only 14% of the models were proposed without contribution of academia (i.e. 6% sole practitioners-based, 6% sole consultants-based, and 2% consultants and practitioners-based models). In fact, development of models involving practitioners' and consultants' contributions were mostly joint with academic researchers (30%). These findings were implying that non-academic researchers were not active and independent in publishing their work in the area of LTS research. Hence, the present review suggests that there is a compelling requirement to gather researchers from every background under one umbrella to develop a more practical oriented model with a sound theoretical foundation in the area of LTS research.

4.3 Model Validation

The primary purpose of the model is to guide industrial managers to apply research practices and theoretical knowledge in the specific area of the organisation. Hence, the researchers should validate the proposed model that encourages industrial managers to adopt readily-validated or tested model in their organisation. The validation of proposed theory plays a vital role to develop a practically useful theory in any research area (Flynn, Sakakibara, Schroeder, Bates, & Flynn, 1990). The present classification will help to identify whether the proposed model was validated by the researcher. The model consists of a set of elements and presents the path to implement these elements in the real manufacturing environment. If the model was applied in real practice, then the model is categorised as validated. The model validation can be useful to realise the shortcoming and limitations of the model. Based on identified limitations, the model can be modified and rebuilt to suit the real industrial practice, experience or feedback. This type of theory building is good to any area of research (Jasti & Kodali, 2015). The validated model always attract practitioners to apply it in the industry. Table 3 presented the frequency of models that were validated in the selected sample of LTS model.

Table 3: Model validation

Category	Frequency	Model's Label
Validated	28	2, 4, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 27, 28, 29, 31, 33, 35, 36, 37
Not yet validated	9	1, 3, 5, 14, 23, 26, 30, 32, 35

The observation from Table 3 showed that majority of the models were validated by applying various research methodologies. A few models were only generally proposed by the researchers to higlight some novelty thought in the area of research. These kinds of research model are only useful to present a new idea to deal with the concerned issues to the future researchers (Jasti & Kodali, 2015). Most of these models were proposed especially for implementation purpose (i.e. roadmap), hence should be validated in the real manufacturing environment.

4.4 Validation Modes

The proposed model can be validated by adopting various research designs, including case study, survey, focus study, and mixed of these methodologies. Case study approach uses qualitative data gathered from interviews, observations or secondary data. Survey approach generally uses quantitative data collected from large number of respondents. Focus study acquire the opinion of various experts to validate the proposed model, which involve techniques such as Delphi and focus group discussion. The analysis on validation modes will asisst future researchers to identify what are possible modes of validation methods available. It is important to identify the validation mode used in previous studies to verify the proposed LTS model. Table 4 displayed the frequency of validation modes for applicability of models.

Table 4: Validation modes

Category	Frequency	Model's Label
Case study (including action research)	15	2, 4, 6, 8, 9, 10, 11, 12, 13, 15, 20, 22, 25, 31, 33
Survey	7	16, 21, 28, 29, 34, 36, 37
Mixed-method	3	7, 17, 18
Focus study	3	19, 27, 32
Conceptual	9	1, 3, 5, 14, 23, 26, 30, 32, 35

Table 4 clearly revealed that most of the models were validated by adopting case study research design. Only few researchers used mixed-method and focus study to validate the proposed model. There were also limited number of study that used survey research design to validate the model. The remaining nine models that were validated by the researchers were categorized as conceptual.

4.5 Elements in the Models

In general, each model proposed has a set of essential elements that usually inter-linked to one another. A comprehensive model often developed through building-up the relationship or synergy between those elements. The present analysis is useful to find out what are the elements used to develop a framework and also useful to specify common elements used in the existing LTS models. This review found that the proposed models addressed a wide range of issues in the area of LTS. Hence, the comparison of these models on same scale was difficult. In fact, in some cases it was an impossible task.

Majority of the researchers like Hines, Found, Griffiths, and Harrison (2008), Testani and Ramakrishnan (2010), Marchwinski (2014), Sisson and Elshennawy (2015), and Poksinska and Swartling (2018) only reported success factors of LTS identified from successfully sustained lean companies. Other group of researchers proposed models to overcome barriers and challenges in sustaining lean transformation efforts (Murti, 2009; Pentlicki, 2014; Schlichting, 2009; Turesky & Connell, 2010). Few researchers discussed LTS with respect to its measurement and statistical relationship with several success factors (Burch, 2008; Glover, Farris, Van Aken, & Doolen, 2013; Marshall, 2014; Rentes, Araujo, & Rentes, 2009). The different views of researchers on LTS resulted in accumulation of many incoherent elements.

Moreover, elements in LTS models can be viewed from two perspectives; (1) broader in nature and (2) issue specific. For instance, the elements like 'leadership', 'culture', and 'process', are in broader sense as proposed by the researchers. Other elements like 'lean leadership', 'organisational learning', and 'human resource management' are issue specific that can be further elaborated into several dimensions. When elaborated, some dimensions might overlapped with the broad elements. For example, organisational learning concept used in Mohd-Zainal, Goodyer, and Grigg (2011) model had seven dimensions including leadership. Whereas, leadership is regarded as a broad element in LTS models such as House of Sustainability (Found et al., 2006) and Sustainable Lean Iceberg Model (Hines et al., 2008). Another example, training and development in Marshall (2014) model is a part of human resource management function, while Turesky and Connell (2010) considered training and development as a broad element. Table 5 presented the frequency distribution of broad and issue specific LTS models.

Table 5: Elements in LTS models

Category	Frequency	Model's Label
Broad	24	1, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 17, 18, 20, 22, 24, 25, 27, 29, 32, 34, 36, 37
Issue specific	13	2, 3, 12, 14, 16, 19, 21, 23, 26, 28, 30, 31, 35

Table 5 clearly indicated that 64% of the models were categorised as generic models with broad elements. The remaining 36% of the models were addressing specific including 'lean leadership', 'blue ocean leadership', 'transformational leadership', 'employee engagement', 'organisational culture', 'lean culture', 'societal culture', 'organisational learning', 'human resource management', and 'lean practice bundles'. The frequency analysis of the elements clearly revealed a deficiency in standardisation of elements used to develop LTS models. This deficiency leads difficulty to specify common elements used in the existing LTS models and propose a unified model without overlapping elements.

Nevertheless, the main purpose of the present review is to identify the common LTS elements instead of comparing the LTS models to propose a unified model. Thus, this review compiled the most popular common elements that repeatedly appeared in LTS models. The phrase and meaning of the elements were considered to group the related elements together under a broader concept (i.e. factor). The frequency of occurrence of popular factors in various LTS models was presented in Table 6.

Table 6: Elements in LTS models

No	Factors	Elements	Sources (Models)
1	Engagement	Lean mindets, behaviours and values Problem solving behaviour Employee attributes and attitudes Employees' discipline Employee empowerment Employee daily accountability and ownership Communication (e.g. two-way, transparency, and effective) Respect employees Labour relations Job design and improvement Job rotation Dedicated lean function Team working Working environment Reward and recognition system Suggestion and feedback system Training and development program Human resource management system Organisational learning Organisational culture inventory and infrastructure Societal culture profile Culture change and development	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 37
2	Strategic	Strategy and alignment Strategic planning Strategic lean intervention Corporate system infrastructure Long-term philosophy	5, 6, 8, 9, 11, 12, 15, 16, 17, 18, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35

No	Factors	Elements	Sources (Models)
		Visionary and forward thinking Organisation's vision Hoshin kanri (policy deployment) Lean transformation deployment Link lean with business strategy Contingency approach	
3	Leadership	Transformational leadership skills Lean leadership principles Blue ocean leadership attributes Servant leadership style Supportive leadership practices Participative leadership approach Leadership from top management Leadership recognition Leader's behaviour Leader standard work Top management support	3, 4, 5, 8, 9, 12, 13, 14, 15, 16, 17, 18, 22, 24, 26, 27, 28, 29, 31, 32, 33, 35
4	Technical	Process management Processes and tools Tools, techniques and technologies Manufacturing processes Management infrastructure	1, 4, 5, 6, 8, 9, 11, 15, 19, 20, 24, 25, 26, 27, 29, 34, 36

Table 6 revealed four popular factors which include engagement factor as the most popular (35 models), followed by strategic factor (24 models), leadership factor (22 models) and technical factor (17 models). Elements grouped under each factor refers to specific intiatives to address issues related to that particular factor. For instance, to engage employees in a sustainable Lean Transformation there were several intiatives proposed by previous researchers such as employee empowerment (Vance, 2017; Veech, 2004), training and development program (Sisson & Elshennawy, 2015; Turesky & Connell, 2010), and effective communication (Burch, 2008; Kok, Mohd Yusof, & Lau, 2019). Another example, previous studies proposed diverse leadership styles to leaders for leading Lean Transformation towards sustainability including; blue ocean leadership (Kok et al., 2019), lean leadership (Dombrowski & Mielke, 2014; Nooraei Ashtiani, 2016), transformational leadership (Testani & Ramakrishnan, 2010), and servant leadership (Veech, 2004).

In addition, it clearly revealed that the different perspectives of the researchers in the study of LTS resulted in the development of incoherent and large number of elements. Under strategic factor alone, there were 11 different elements proposed in the existing models. However, authors believe that all these elements can be further clarified according to its detailed meaning (i.e. operational definition) and followed by a series of validity assessment. In order to develop a unified LTS model with standard elements, a standard definition for every included element in the model need to be specified first. Thus, future researchers should conduct face and content validation using experts' opinions from multiple background (e.g. academia, consultants and practitioners). Afterward, construct validation like convergent and discriminant validity via statistical tests might help future researchers to verify whether each element is truly unique or identical to one another.

5. Conclusions

The study of LTS is one of the emergent topics in the area of operations management, which resulted in many researchers contributing to develop the models. The present review reported that no research review articles were available to find out inconsistencies and inadequacies in the existing model of LTS. This kind of analysis is useful as a preliminary step to develop a unified model with a standard set of elements in the field of LTS study. Hence, the present study conducted literature survey and analysed 37 LTS models based on five criteria; (1) originality of models, (2) source of the models, (3) model validation, (4) validation mode, and (5) elements in the model. The primary objective of the present review was to compare existing LTS models in order to recommend future research opportunities in the area of LTS study.

The review found that the participation of consultants in the development of LTS models were very low as compared with academia and practitioners. This article also revealed that many proposed models are novel models and mostly validated by using case study research design. This review also investigated to identify the elements that had been studied by various researchers and to know what are common (standard) elements proposed in the existing LTS models. It was evident that a large number of dissimilar elements were used by researchers to propose the LTS models. Hence, the identification of common elements from the literature is a difficult task to accomplish. Nevertheless, all these elements are from four organisational factors including employee engagement, leadership, strategic, and technical.

The limitation of present review was not discussing about the meaning (definition) of each element in detailed, it will consider as a future part of the research due to scope of this article. Thus, this review recommend that future researchers need to dedicate their efforts to find out the standard definition for every identified common element in order to develop a unified LTS model. Authors also suggest verifying reliability and validity of every selected elements in the unified LTS model using appropriate statistical test such as exploratory factor analysis, confirmatory factor analysis, and confirmatory component analysis.

References

Abdul Wahab, A. N., Mukhtar, M., & Sulaiman, R. (2017). Lean production system definition from the perspective of Malaysian industry. *Asia-Pacific Journal of Information Technology and Multimedia, 6*(1).

Alukal, G. (2006). Keeping lean alive. *Quality Progress, 39*, 67-69.

Boell, S. K., & Cecez-Kecmanovic, D. (2015). On being 'systematic' in literature reviews in IS. *Journal of Information Technology, 30*, 161-173.

Burch, M. K. (2008). *Lean longevity: Kaizen events and determinants of sustainable improvement.* (Doctor of Philosophy in Business Administration), University of Massachusetts Amherst, Boston, MA.

De Vaus, D. (2002). *Surveys in social research* (5th ed.). New South Wales, Australia: Allen & Unwin.

Dombrowski, U., & Mielke, T. (2014). Lean leadership: 15 rules for a sustainable lean implementation. *Procedia CIRP, 17*, 565-570.

Emiliani, M. (2016). Is Lean the same as TPS? Retrieved from https://bobemiliani.com/is-lean-the-same-as-tps/

Flynn, B. B., Sakakibara, S., Schroeder, R. G., Bates, K. A., & Flynn, E. J. (1990). Empirical research methods in operations management. *Journal of Operations Management, 9*(2), 250-284. doi:10.1016/0272-6963(90)90098-x

Found, P. A., Beale, J., Hines, P., Naim, M., Rich, N., Sarmiento, R., & Thomas, A. (2006). *A theoretical framework for economic sustainability of manufacturing*. Retrieved from Cardiff, AY: http://orca.cf.ac.uk/41079/

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). New York, NY: McGraw-Hill Companies, Inc.

Furunes, T. (2019). Reflections on systematic reviews: Moving golden standards? *Scandinavian Journal of Hospitality and Tourism, Editorial*, 1-5.

Glover, W., Farris, J., Van Aken, E., & Doolen, T. (2013). Kaizen event result sustainability for lean enterprise transformation. *Journal of Enterprise Transformation, 3*(3), 136-160. doi:10.1080/19488289.2013.818596

Gurumurthy, A., & Kodali, R. (2010). Analysis of Lean Manufacturing frameworks. *Journal of Advanced Manufacturing Systems, 09*(01), 1-30. doi:10.1142/s0219686710001776

Hines, P., Found, P. A., Griffiths, G., & Harrison, R. (2008). *Staying lean: Thriving not just surviving*. Cardiff, AY: Lean Enterprise Research Centre, Cardiff University.

Jasti, N. V. K., & Kodali, R. (2015). A critical review of lean supply chain management frameworks: Proposed framework. *Production Planning & Control, 26*(13), 1051-1068. doi:10.1080/09537287.2015.1004563

Jørgensen, F., Matthiesen, R., Nielsen, J., & Johansen, J. (2007). Lean maturity, lean sustainability. In J. Olhager & F. Persson (Eds.), *Advances in Production Management Systems* (pp. 371-378). Aalborg, Denmark: IFIP International Federation for Information Processing.

Kilpatrick, J. (2003). Lean principles. *Utah Manufacturing Extension Partnership*, 1-5.

Kipfer, B. A. (2005). *Roget's 21st Century Thesaurus* (3rd ed.). New York, NY: Dell Publishing.

Kok, L. L., Mohd Yusof, S., & Lau, D. H. C. (2019). Blue ocean leadership in lean sustainability. *International Journal of Lean Six Sigma, 10*(1), 275-294. doi:10.1108/IJLSS-06-2016-0029

Lean Learning Center, L. L. C. (2008). When the low hanging fruit disappears... Sustaining lean for the long term. Retrieved from Industry Week website: http://www.industryweek.com/workforce/when-low-hanging-fruit-disappears-sustaining-lean-long-term

Mann, D. W. (2015). *Creating a lean culture: Tools to sustain lean conversions* (3rd ed.). Boca Raton, FL: CRC Press.

Marchwinski, C. (2014). Sustain your lean business system with a "Golden Triangle". *Knowledge Center.* Retrieved from http://www.lean.org/common/display/?o=2592

Marshall, D. A. (2014). *Lean transformation: Overcoming the challenges, managing performance, and sustaining success.* (Doctor of Philosophy), University of Kentucky, Lexington, KY.

Mohd-Zainal, A., Goodyer, J., & Grigg, N. (2011). *Organisational learning to sustain lean implementation in New Zealand manufacturing companies*. Paper presented at the 3rd International Conference on Information and Financial Engineering IPEDR Singapore.

Mohd Yusof, S. r., & Aoki, K. (2016, March 8-10). *Proposed lean sustained factors.* Paper presented at the The 6th International Conference on Industrial Engineering and Operations Management (IEOM 2016), Kuala Lumpur, Malaysia.

Mohd Yusof, S. r., & Aspinwall, E. (2000). Total quality management implementation frameworks: Comparison and review. *Total Quality Management, 11*(3), 281-294. doi:10.1080/0954412006801

Murti, Y. (2009). *Sustaining lean in New Zealand manufacturing organisations.* (Master of Technology in Engineering and Industrial Management), Massey University, Palmerston North, AC.

Nooraei Ashtiani, N. (2016). *Building a sustainable lean culture: A holistic lean leadership model.* (Master of Applied Science in Industrial Engineering), Concordia University, Montreal, QC.

Osman, A. A., Othman, A. A., & Abdul Rahim, M. K. I. (2020a). Defining and developing measures of lean sustainability for manufacturing sector. *IOP Conference Series: Materials Science and Engineering, 864*, 012111. doi:10.1088/1757-899x/864/1/012111

Osman, A. A., Othman, A. A., & Abdul Rahim, M. K. I. (2020b). Lean manufacturing adoption in Malaysia: A systematic review. *International Journal of Supply Chain, Operation Management and Logistics, 1*(1), 1-35. doi:10.35631/ijscol.11001

Pentlicki, J. H. (2014). *Barriers and success strategies for sustainable lean manufacturing implementation: A qualitative case study.* (Doctor of Management in Organizational Leadership), University of Phoenix, Phoenix, AZ.

Poksinska, B., & Swartling, D. (2018). From successful to sustainable lean production: The case of a Lean Prize Award Winner. *Total Quality Management & Business Excellence, 29*(9), 996-1011.

Rentes, A. F., Araujo, C. A. C., & Rentes, V. C. (2009). *Best practice examples in sustaining improvements from Lean implementation.* Paper presented at the Proceedings of the 2009 Industrial Engineering Research Conference (IeRC), Marriott Resort, Miami.

Roth, G. (2011). Sustaining lean transformation through growth and positive organizational change. *Journal of Enterprise Transformation, 1*(2), 119-146.

Ruffa, S. A. (2011). *Going lean fieldbook - A practical guide to lean transformation and sustainable success*. New York, NY: American Management Association (AMACOM).

Schlichting, C. (2009). *Sustaining lean improvements.* (Master of Science in Manufacturing Engineering), Worcester Polytechnic Institute, Worcester, MA.

Sisson, J., & Elshennawy, A. (2015). Achieving success with lean. *International Journal of Lean Six Sigma, 6*(3), 263-280.

Testani, M. V., & Ramakrishnan, S. (2010). *The role of leadership in sustaining a lean transformation.* Paper presented at the Proceedings of the 2010 Industrial Engineering Research Conference (IeRC), Springfield, MO.

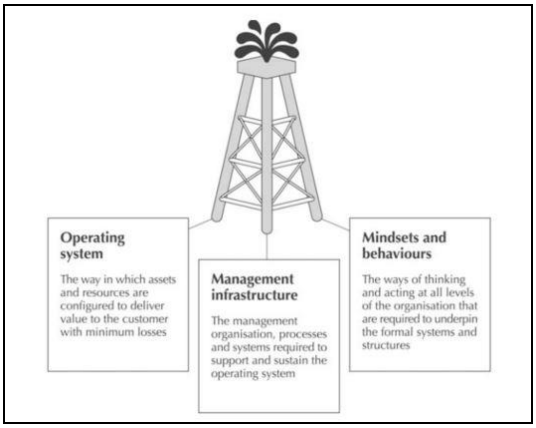
Thomé, A. M. T., Scavarda, L. F., & Scavarda, A. J. (2016). Conducting systematic literature review in operations management. *Production Planning & Control, 27*(5), 408-420.

Turesky, E. F., & Connell, P. (2010). Off the rails: Understanding the derailment of a lean manufacturing initiative. *Organization Management Journal, 7*(2), 110-132.

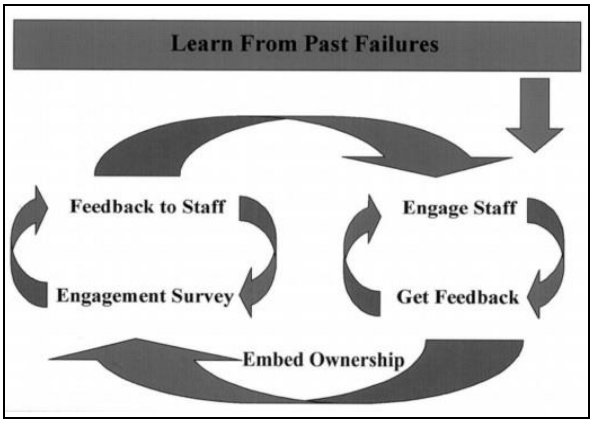
Vance, G. A. (2017). *Lean behaviors for sustaining the implementation of lean methodologies in multi-national companies: A qualitative case study*. (Doctor of Business Administration), Liberty University, Lynchburg, VA.

Veech, D. S. (2004). A person-centered approach to sustaining a lean environment: Job design for self-efficacy. *Defense Acquisition Review Journal*, 159-170.

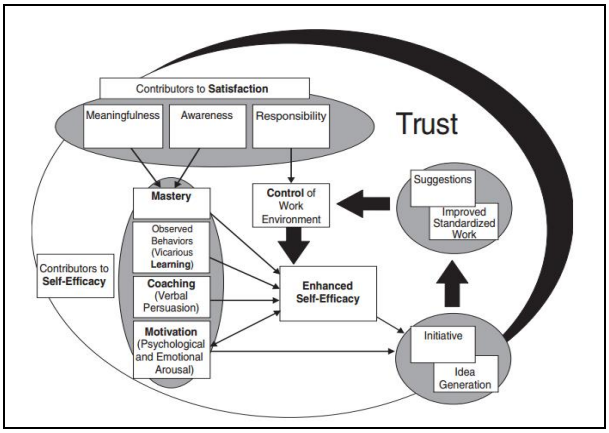
==========



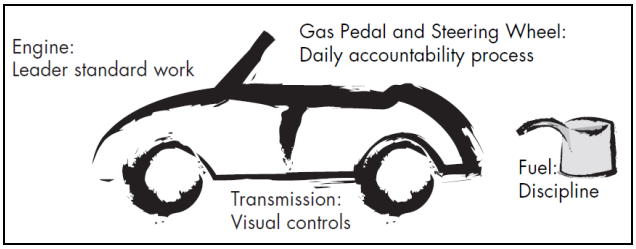
Model 1: Sustainable Operational Improvement Model (Drew, McCallum, & Roggenhofer, 2004)



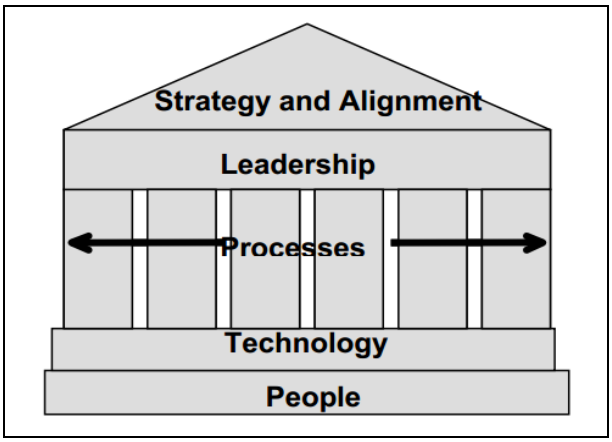
Model 2: Long Term Sustainability Model (Lucey, Bateman, & Hines, 2004)



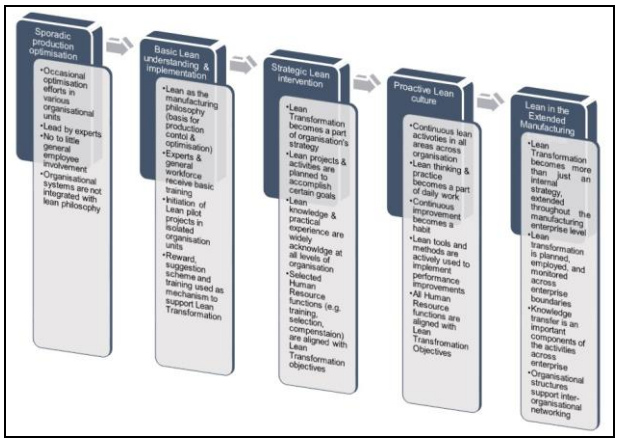
Model 3: Job Design for Self-Efficacy Model (Veech, 2004)



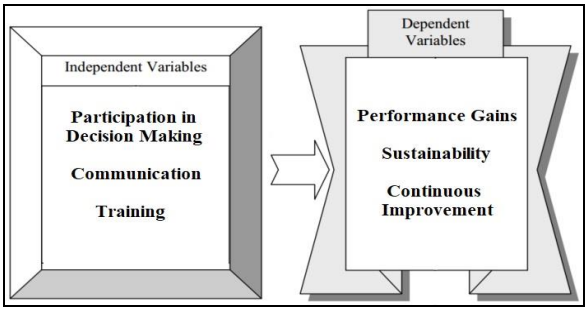
Model 4: Lean Management System (Mann, 2005)



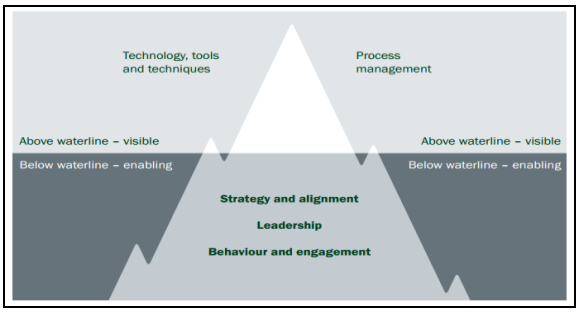
Model 5: House of Sustainability (Found et al., 2006)



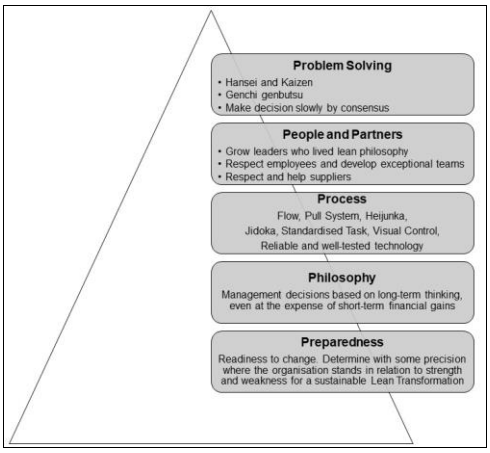
Model 6: Lean Capability Model (Jørgensen, Matthiesen, Nielsen, & Johansen, 2007)



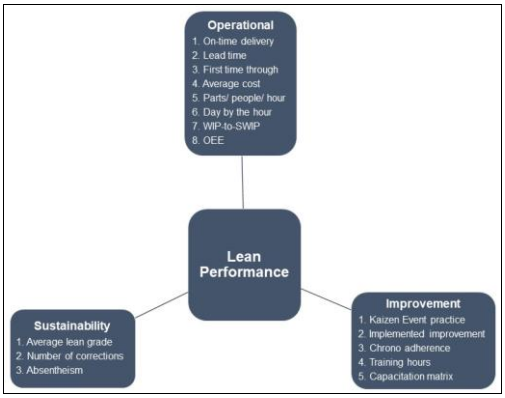
Model 7: Sustainable Improvement for Lean Longevity Framework (Burch, 2008)



Model 8: Sustainable Lean Iceberg Model (Hines, Found, Griffiths, & Harrison, 2008)

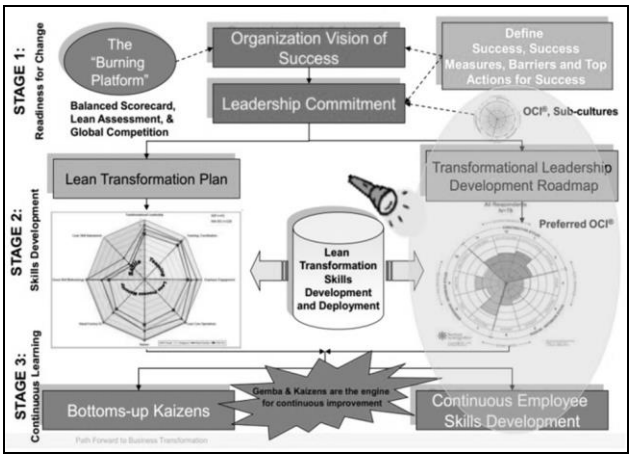


Model 9: 5Ps Model (Murti, 2009)

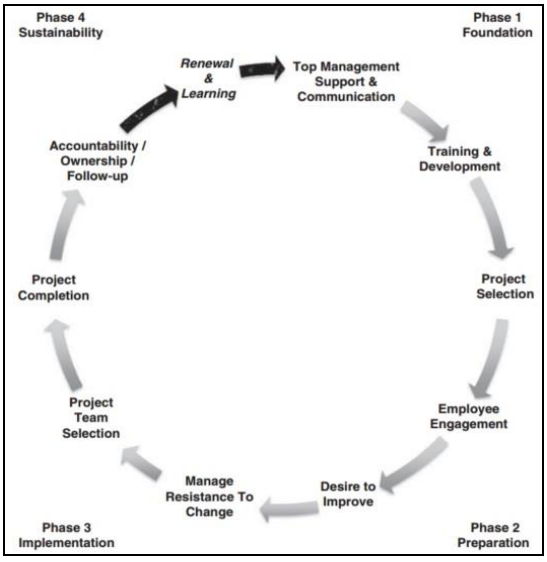


Model 10: Lean Performance Measures (Rentes, Araujo, & Rentes, 2009)

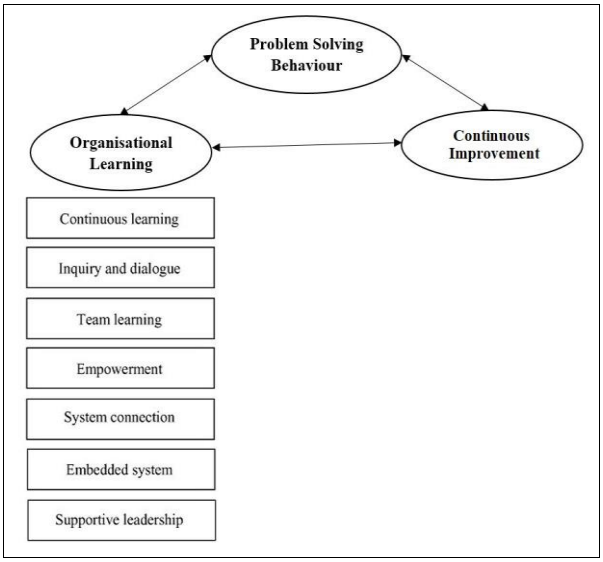
Model 11: Sustaining Lean Improvements Model (Schlichting, 2009)



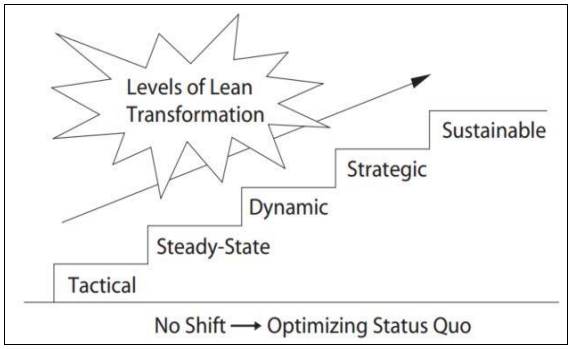
Model 12: The Path Forward Lean Deployment (Ramakrishnan & Testani, 2010; Testani & Ramakrishnan, 2010)



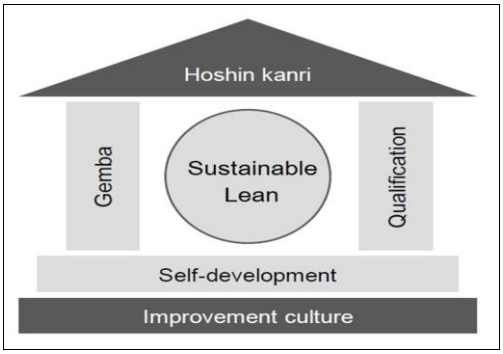
Model 13: Phases for Lean Project Sustainability (Turesky & Connell, 2010)



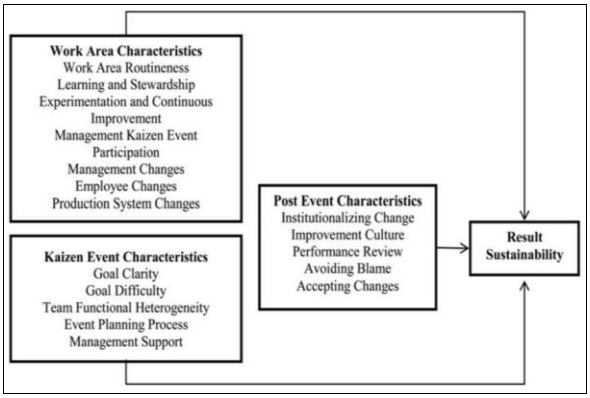
Model 14: Organisational Learning Framework to Sustain Lean Implementation (Mohd-Zainal, Goodyer, & Grigg, 2011)



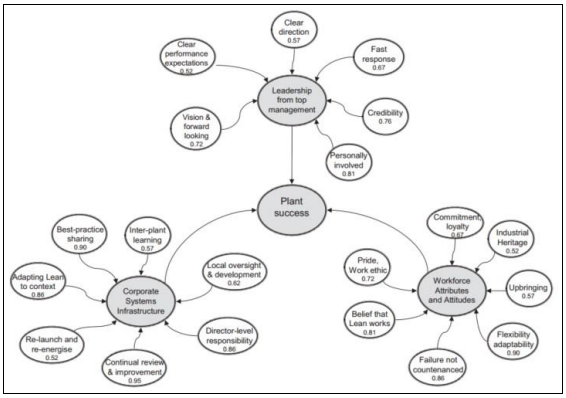
Model 15: Lean Maturity Levels (Ruffa, 2011)



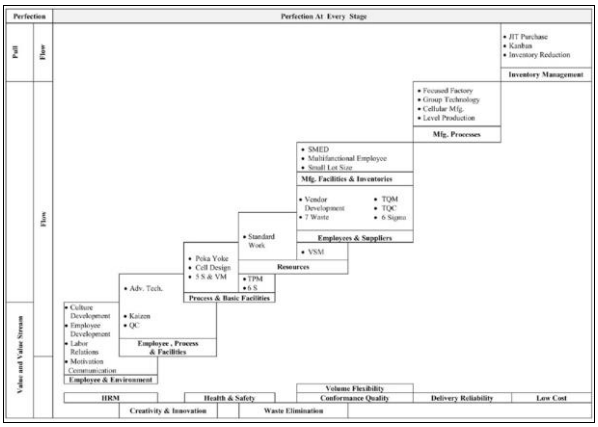
Model 16: Lean Leadership Model for a Sustainable Lean Implementation (Dombrowski & Mielke, 2013, 2014)



Model 17: Kaizen Event Outcome Sustainability Model (Glover, Farris, Van Aken, & Doolen, 2013)

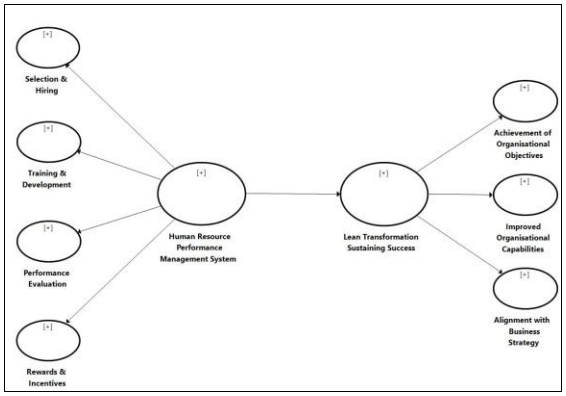


Model 18: Lean System Survival Model (Taylor, Taylor, & McSweeney, 2013)

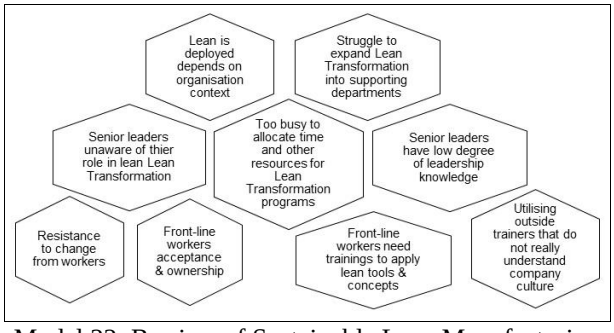


Model 19: Lean Practice Bundles (Jadhav, Mantha, & Rane, 2014)

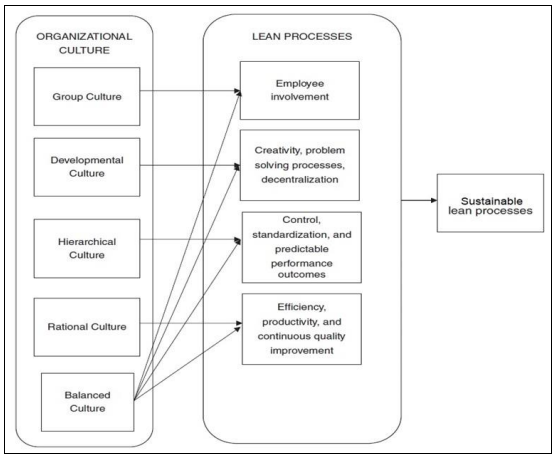
Model 20: The Golden Sustainability Triangle (Marchwinski, 2014)



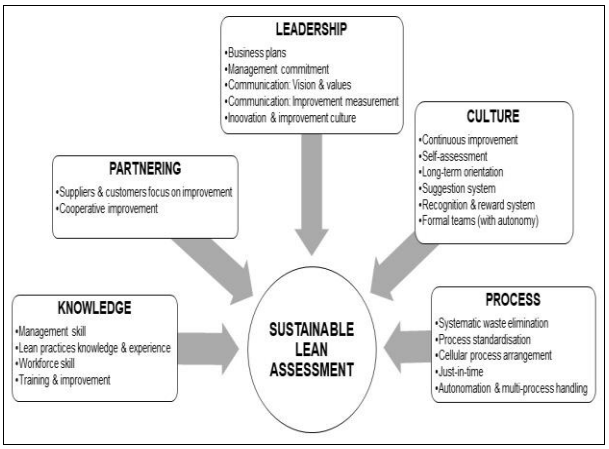
Model 21: Human Resource Performance Management System for Lean Transformation Sustaining Success (Marshall, 2014)



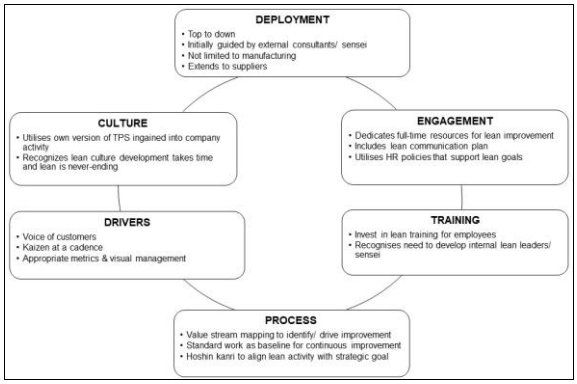
Model 22: Barriers of Sustainable Lean Manufacturing (Pentlicki, 2014)



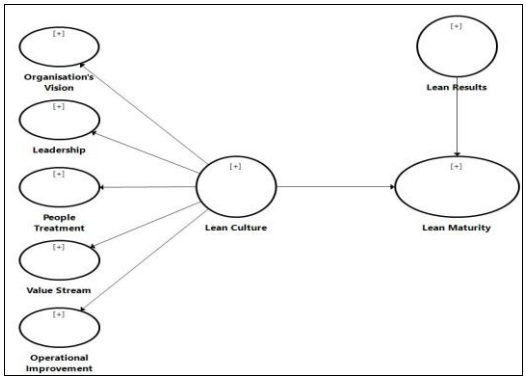
Model 23: Organisational Culture Infrastructure for a Sustainable Lean Process (Pakdil, Leonard, & Bennett, 2015)



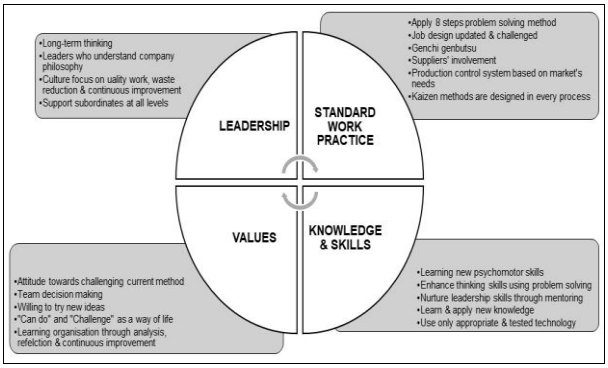
Model 24: Sustainable Lean Assessment Model (Schröders & Cruz-Machado, 2015)



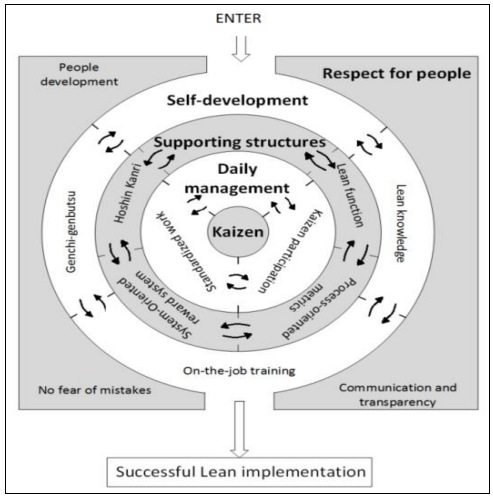
Model 25: Successful Sustained Lean Improvement Model (Sisson & Elshennawy, 2015)



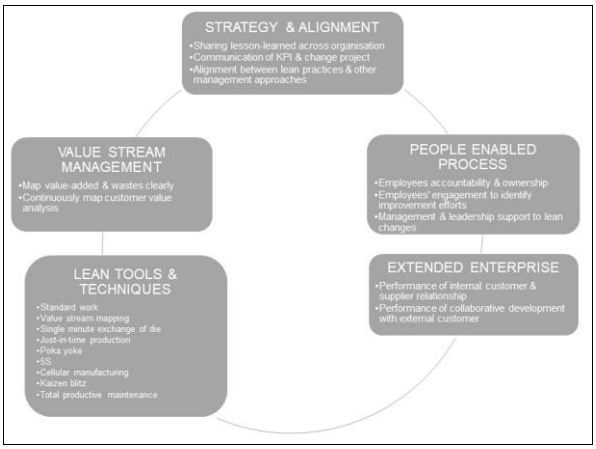
Model 26: Lean Maturity Model (Urban, 2015)



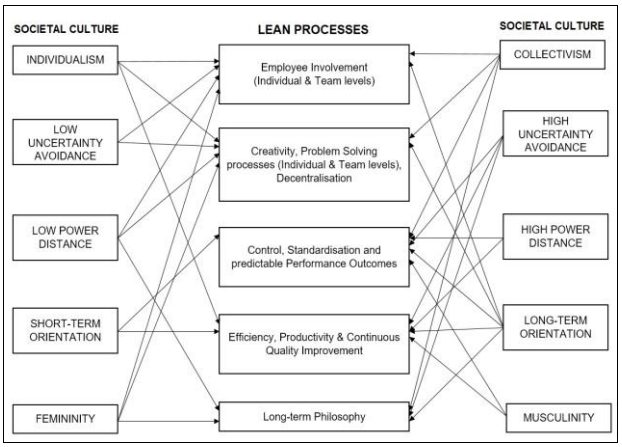
Model 27: Sustained TPS State (Mohd Yusof & Aoki, 2016)



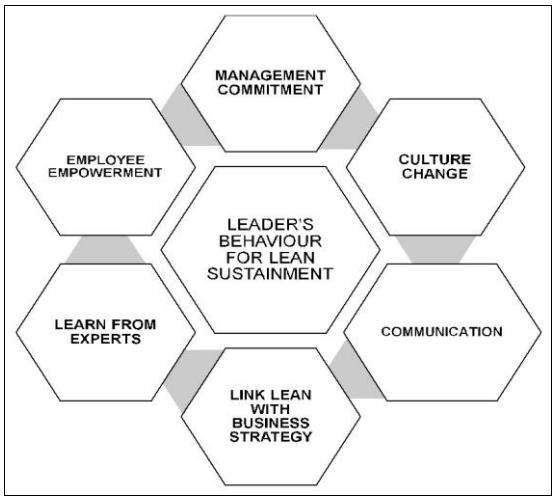
Model 28: Lean Leadership Model for a Sustainable Lean Culture (Nooraei Ashtiani, 2016)



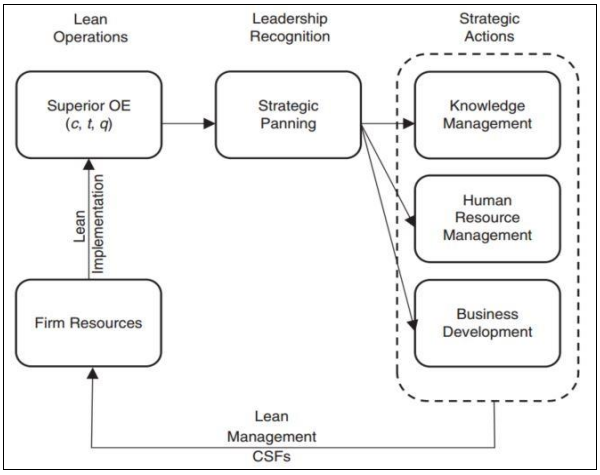
Model 29: Lean Maturity Attributes (Setianto & Haddud, 2016)



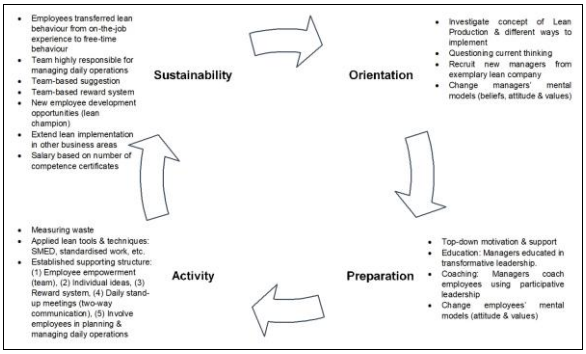
Model 30: Societal Culture Profiles for a Sustainable Lean Process (Pakdil & Leonard, 2017)



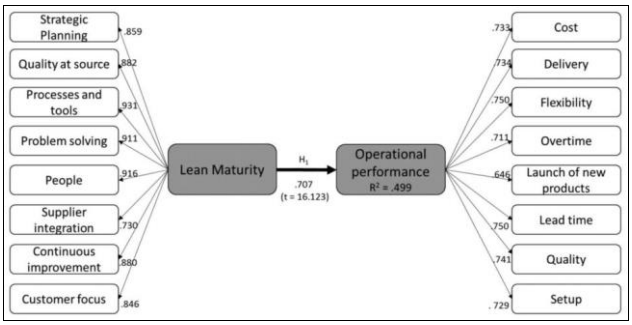
Model 31: Leader's Behaviour for Lean Sustainment (Vance, 2017)



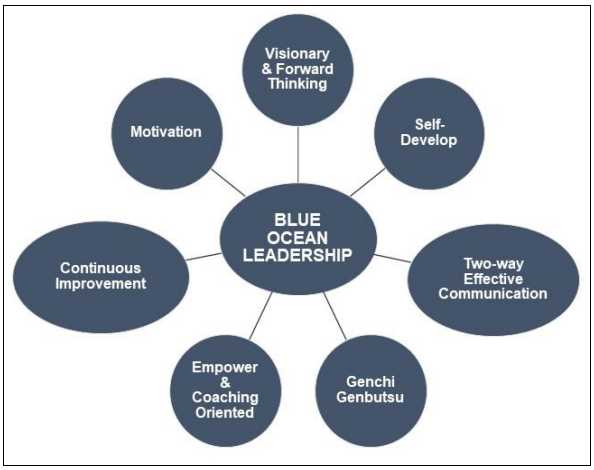
Model 32: Strategic Lean Actions for Sustainable Competitive Advantage (Hallam, Valerdi, & Contreras, 2018)



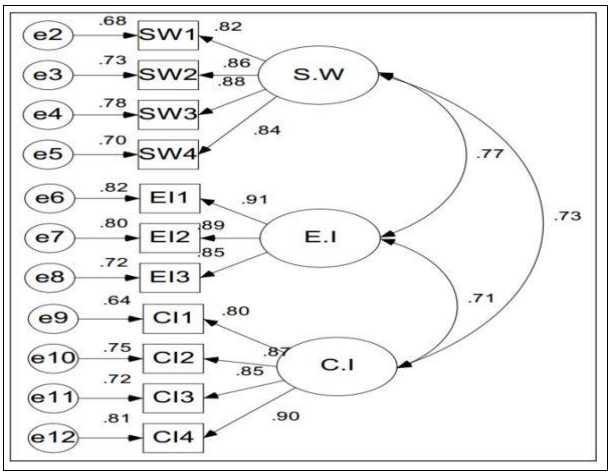
Model 33: Sustainable Lean Production Phases (Poksinska & Swartling, 2018)



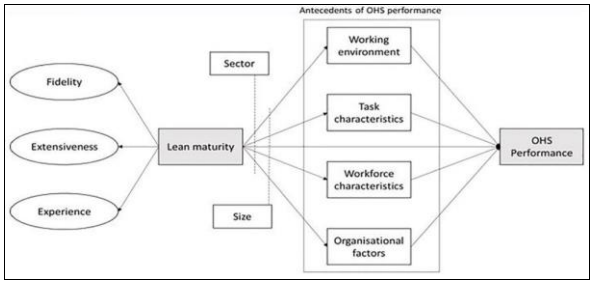
Model 34: Lean Maturity and Operational Performance (Santos Bento & Tontini, 2018)



Model 35: Blue Ocean Leadership in Lean Sustainability (Kok, Mohd Yusof, & Lau, 2019)



Model 36: Sustaining Lean Improvement Model (Habidin, Mohd Zubir, Mohd Fuzi, & Salleh, 2020)



Model 37: Lean Maturity and Operational Health and Safety Performance (Mousavi, Jazani, Cudney, & Trucco, 2020)