SMES HANDICRAFT PRODUCTION MODEL WITH LEAN - SIX SIGMA
MÔ HÌNH SẢN XUẤT THỦ CÔNG CHO SMES THEO LEAN - SIX SIGMAT

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Abstract
Handicraft production has complexity in its product, as well as manufacturing processes. Especially in case of Small and Medium Enterprises (SMEs), the production characteristics are chaotic and hard to control. Several problems can be pointed out, e.g. line unbalance, excessive stock, improper work assignment, ambiguous workflow,… Such a production system with these flaws incorporated cannot be reliable and effective. However; in Vietnam, this situation is common due to the small size of business operation, large number of workers, and cheap price for labour hour. The problems sometime are hiding due to the incompetence of management. In this paper, an operating model for Vietnamese SMEs' handicraft production is proposed, bearing the concepts and principles of Lean - Six Sigma philosophy. A case study is conducted in a SME handicraft manufacturing firm in Vietnam, indicated effective results toward a more productive manner, which is systematic and controllable, providing its management quick response to customers' demand meanwhile keeping the investment as lean as possible.
Keywords: *Handicraft, Vietnamese production, Lean - Six Sigma, Lean, operation research.*

Tóm tắt
Ngành sản xuất thủ công đòi hỏi sự phức tạp trong cấu trúc sản phẩm, cũng như trong quá trình sản xuất. Đặc thù sản xuất thủ công tại các doanh nghiệp vừa và nhỏ (SMEs) thường là hỗn loạn và khó kiểm soát. Một số vấn đề thường gặp là mất cân bằng chuyền, tồn kho dư thừa, phân công công việc không hợp lý, dòng chảy sản xuất rối loạn,… dẫn đến hệ thống sản xuất kém hiệu quả và có độ tin cậy thấp. Tuy nhiên tại Việt Nam, tình hình này lại trở nên phổ biến do quy mô sản xuất thường nhỏ, dư thừa lao động với giá nhân công rẻ. Những vấn đề trên cũng dễ bị ẩn đi do trình độ quản lý kém. Bài báo này đưa ra một mô hình vận hành cho các SMEs sản xuất thủ công tại Việt nam, với sự kết hợp các triết lý Lean - Six Sigma. Một dự án cải tiến được triển khai thí điểm tại một doanh nghiệp sản xuất thủ công tại Việt Nam, cho thấy những hiệu quả tích cực mà mô hình này mang lại.
Từ khóa: *Sản xuất thủ công, sản xuất tại Việt Nam, Lean-Six Sigma, sản xuất tinh gọn, quản lý vận hành.*

1. Introduction

In the revolutionary era of industrial revolution 4.0 Lean - Six Sigma improvement tools have been wide applied in different manufacturing industries, bringing competitive advantages [1], [2], with tremendous benefit such as lower inventory, higher responsiveness, human resource development, etc. In Vietnam, some pioneer researchers in this area gained significant aftermath in [3]-[6], with case studies are conducted in large enterprises and corporation. However, in Vietnam, the major of manufacturing firms are SMEs. Their organizational structures typically are not in any well-designed shape, thus lead to deficiency in operation. And unfortunately, they do not have sufficient access to Lean - Six Sigma. Especially in handicraft manufacturing, there is a lack in research and development which can be applicable and scalable due to the scarceness of improvement projects. Only few researches have been conducted in this area, thus there is a lack of model for further benchmarking exercises.

This research is elaborated based on the theoretical background of Lean - Six Sigma philosophies, take into consideration of status quo of Vietnamese industries, to suggest an operation model specialized for handicraft manufacturing SMEs in Vietnam. A case study which is conducted in Vietnam Pop-up Cards & Handicraft JSC obtained potential result after four-month improvement project showing that the model is applicable.

2. Literature review

Globally, industry experts share the same interest of how to optimize the operation of manufacturing firms, cutting down costs and improving business profit [1], [2], [7], [8]. Align with these objectives, Lean-Six Sigma is a comprehensive philosophy which brings many tools and initiatives which were welcomed in many manufacturing industries. Lean philosophies mainly aim at identify bottleneck in

production processes, improve it to smoothen the value stream of production, meanwhile looking for excessive and redundant activities which do not bring value to customers to eliminate, thus optimize the resources utilization. Six Sigma philosophies, on the other hand, focus on stabilizing existing manufacturing processes or designing reliable ones, to maintain a sustainable and controlled level of product quality, bringing higher satisfaction level of customers which directly yield higher business profit. Lean-Six Sigma is a new doctrine which combines both tools and concepts from the two fields, and is more flexible thus more favorable for manufacturing companies around the world. Lean-Six Sigma were adopted in Vietnam not long ago, which served well in automotive industry: to reduce the waiting waste and stabilized product quality [9], electrical industry: re-arrange the facility layout to improve productivity [10], furniture making: design a leaner system with more balanced pace [11]. One possible approach for Vietnamese SMEs to choose the suitable Lean tools and a roadmap to implement them are mentioned by Tuan-anh et al. in [12]. For each type of manufacturing system, the Lean-Six Sigma tools with its recommended usage frequency and respective implementing milestones are also suggested.

However, handicraft manufacturing is a difficult field due to its intensiveness of labor activities and the dissimilarity in product structure, time and motion of processes. Even in the world, there is a lack of research on this topic, due to the sparsely scattered of handicraft manufacturing firms. In Morocco, Chouiraf et al. took the benefit of improvement tools to standardized the handicraft production of Moroccan artisanal SMEs [13], [14]. In Vietnam, there has been no research on this field, thus there is want for deeper analysis for Lean - Six Sigma application for handicraft production, especially SMEs.

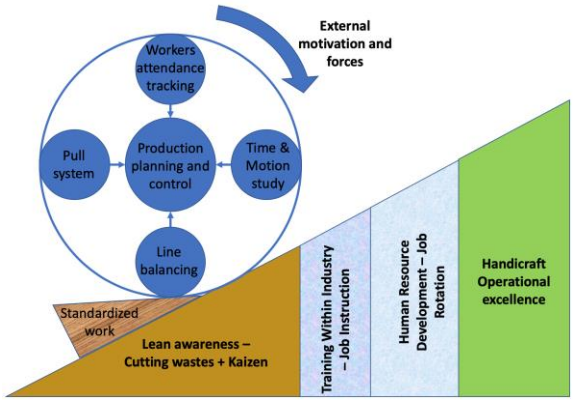
Beside of normal issues that are commonplace in typical Vietnamese SMEs, handicraft manufacturing contains other problematic ones, due to the fact that it usually requires lots of labor work, thus can lead to many unnecessary wastes during operation. Through literature review of SMEs manufacturing in Vietnam, and interview with several handicraft manufacturing firms, some factors are listed as common problems and losses of handicraft production system for Vietnamese SMEs, as described in table 1 below. For each problem, there is usually one or more Lean-Six Sigma solution which can be applicable, according to the classification mentioned in [12].

Table 1. The common problems in Vietnamese SMEs handicraft production

Problems and losses	References	Possible Lean - Six Sigma solution
Job production method, relies on the workers' skills to finish one-off production.	[11], [15]	Optimize work method, aim towards small batch flow. => shorter queuing and waiting time, more defect-prone.
Excessive and inequal process motion and time.	[11], [15]	Time & Motion study, Standardized work. => more stable and convenient process motion, more time-balance
No MRP functionality. Thus, no inventory control, due to the uncertainty of production. Poor connection with suppliers.	[15]	Deploy production planning and control function, in integration with Lean philosophies. => proactively prepare for production, more input quality.
Uncontrolled work attendance and varied work skills, due to the small scale of enterprises. No sufficient internal training/coaching program.	[3], [4], [15]	Standardized work. Keep good track on absenteeism. Job instruction. Job rotation. => more efficient internal knowledge sharing scheme.

3. Methodology

According to [12], handicraft production belongs to the group of high interaction between workers and working tools, thus may implement improvement tools such as Line balancing, Kanban, JIT, … with the emphasis on labor utilization. Based on the current situation of Vietnamese firms, an effective and sustainable operating model of handicraft production is shaped in Figure 1. This model is integrated with Lean - Six Sigma philosophy to improve the operation efficiency.



Source: Own-study.

Figure 1. Sustainable handicraft operation model

At first, training about the Lean awareness of cutting wastes and Kaizen is prerequisite, and need to be maintained throughout the operation as a knowledge base. As the firm operates under the incentives from external motivation and forces, production planning and control (PPC) plays a vital role to drive the whole system in general, and MRP function as well as inventory level in particular. In order to gather necessary information for PPC to derived effectively, time & motion study needs to be in record, workers' attendance need to be in well monitoring. Other supporting philosophies to coordinate the production processes were pull system and line balancing, which ensuring the optimal utilization of labor work.

Since this operating model relied heavily on labor work, standardized work is a primary element, which wedges the operation from degrading. However, in order to upgrade to achieve handicraft operational excellence, job instruction and job rotation are important in educate and training the personnel of the system, to conform with the work requirement and standard, acceptable processing time and motion, in order to stabilize output quality.

Simulation was usually used in investigating the effect of new improvement on a production system. In Vietnamese manufacturing, this method is adopted in researches [11], [16], which gave accountability for the correspondence to the realistic result. In this research, before implementing improvement tools, the research team also conducted simulation test on Arena software. The simulation result was mentioned in the case study, along with the respective realistic result.

4. Case study and result

The case study is conducted in Vietnam Pop-up Cards & Handicraft JSC, a company specialized in designing and manufacturing pop-up cards, operates production in thousands of product variants. In the scope of this paper, the authors will only mention the production aspect of this company, as the interest subject of the improvement project. Several typical products are represented in Table 2 below, and according to the fact that each product variant has a different structure, thus requires different processes to produce, the production management will be cumbersome and problematic to monitor.

The workforce size is approximately 50 workers, with several major production processes are cutting, assembling, gluing, stitching, packaging. Due to the deficiencies of production system, the firm were suffered from some systematic problems as described in the Table 3 below. This information is the brainstorming result of a workshop which was held in the shop floor, with the attendance of the directors, chief officers and 20 experienced workers of the company.

Before change production type from job production one into a leaner one: small batch with Kanban, simulation test is conducted with Arena software. Three major production processes (i.e., assembling, gluing, stitching) are taken into consideration, involved three workers with different skill level at each of these processes. In job production, each worker conducts three tasks at one workstation, despite the fact that one worker is better at assembling, the other is good at gluing, etc. Since change into batch production, each worker is assigned into one workstation based on their skill level at which they are best of. The plant layout needs to be modified according to Figure 2.

Table 2. Typical products in the case study

Type	Short description	Example image
Animal	The structure resembles the form and shape of animals. E.g.: The parrot.	
Human beings	The structure is formed based on human activities. E.g.: The lovers.	
Belongings	The structure is the combination of stuff and belongings. E.g.: The gift.	
Buildings	The structure is formed according to famous buildings and architecture.	

Table 3. The situation before implementing the improvement project

	Input	Process	Output
Problem	Lack of optimal material order quantity. Loose connection with suppliers. Lack of inventory monitoring activities.	Ambiguous standard work instruction. Job production method, despite of large amount of order quantity. No training activities. Inefficient workstation layout. Intermittent communication between departments.	No tracking of loss ratio in output inventory. No record for defect and potential problems.
Consequences	Large and required space for inventory. Costly inventory with no tracking of usage status.	Uncontrolled WIP level. Higher ratio of defects. Under-utilized workers' competence.	No improvement plan was suggested. Not any root cause is tracked.

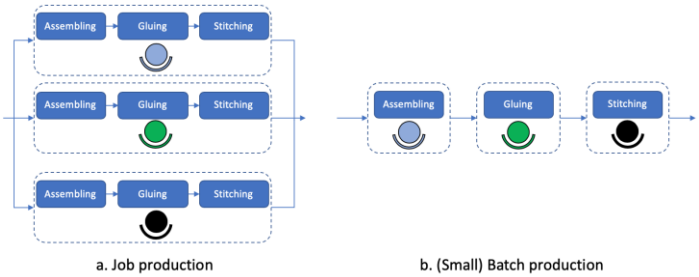


Figure 2. Changing in production method and layout

Table 4. List of tools applied

No.	Tools	Details	Initial status	Result
1	EOQ calculation. Suppliers management.	Calculating the EOQ of each part by breaking down their price and inventory requirement. Develop close connection with suppliers.	No optimum order quantity for each part. Unpredicted order lead time.	Reduce approx. 40% order lead-time of 3 suppliers. Deploy one order multi delivery policy. Inventory space reduced 30%.
2	Inventory tracking + Safety stock	Use inventory card with procedure to record usage rate. Calculate the safety stock for each part.	No usage rate record. No safety stock level.	Reduce 25% of finished-part inventory, 20% of material inventory. Approx. 18.000 USD.
3	Changing production type	Changing from job production into small batch production with Kanban card.	Approx. 45.000 part/day. Total failure rate = 0.0647%	Simulation result: 50.000 part/day. Total failure rate 0.0254%. Practical result: Approx. 48.000 part/day. Total failure rate = 0.0275%. Process failure rate reduce 71% at peak.
4	Standardized work	Design standardized work instruction for each workstation based on the new plant layout.	No work description. Vague quality requirement.	Biggest defect quantity reduced 70%.
5	Training within industry - Job Instruction	Deploy Job Instruction method for team leaders, with the designed standardized work.	No training activities.	Team leaders have 15% time for training and coaching activities.
6	Time & Motion study	Observation for each process, and record temporal data. Assign time allowance for each task.	No record.	Time variation within 10% for workers in the same class.
7	Production planning	Elaborate concept of semi-automated production planning, based on time study and approximation of learning curve.	No reliable production planning.	MRP function formed. Simulation result: Planning has 97% of accuracy. Practical result: 93%.
8	Production control	Perform controlling with pull strategy, with Kanban card for small lot size.	No control activities within one day.	Control has 90% of efficiency, within one day frame.
9	Job rotation	Rotate workers among workstation.	No HR development activities.	More readiness in work.

The simulation was run for 3 weeks, with 10 most frequent types of product with different task time. After gaining the result of improvement, a new layout and production method is applied into practice. Other improvement tools implemented in this improvement project are listed in the Table 4 below, in chronological order, with their details, and respective initial status and result.

5. Conclusion

In this research, handicraft production and its complexity, chaotic characteristics were taken into consideration, and suitable Lean-Six Sigma tools were chosen to be applied for each problem of typical handicraft firms. Based on literature review and interview, an operating model for Vietnamese SMEs in this type of manufacturing were elaborated, which integrated improvement philosophy and tools. This theoretical model can help other SMEs handicraft manufacturing firms benchmark their production system, and foresee which part they are in lack of, or in underestimation thus can cause deficiency in their operation. By fulfil the components for a sustainable operating model, their resources can be easily optimized with customer-need orientation.

A case study conducted within the framework of improvement project proved the efficiency of the operating model. The result of the case study can be used as expecting aftermath for companies those are planning to perform Lean measures on their system, in correspondence with the exemplary scale of the pilot company. However, this operating model is still in lack of factors such as absenteeism, workers readiness, skill variation. Other production monitoring methods can be further deployed to optimize this model such as varied cycle time, adaptive production sequence, flexible line balancing, which can be targeted at for future research.

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