

A Study on the Production Systems of Apparel Manufacture

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Abstract

The purposes of this study were to 1) identify types and usage levels of production systems, 2) classify apparel manufacturers based on production systems and 3) investigate relationship between characteristics of apparel manufacturers and production system. Apparel manufacturer's characteristics included product line and the number of employees.

For this study, the questionnaires were administered to 215 apparel manufacturers in metropolitan area from Feb. to Mar. 1998. Employing a sample of 201, data were analyzed by using factor analysis, descriptive statistics, cluster analysis, discriminant analysis, and multivariate analysis of variance(MANOVA).

The following are the results of this study:

1. The production system was identified as three types of production system such as the management centered system, the product centered system and the worker centered system.

2. Based on the three types of the production system, apparel manufacturers were classified into manager centered and product centered groups.

3. With respect to product line, men's wear manufacturers were operated the most frequently by management centered system and women's wear manufacturers were operated the most frequently by worker centered system. With respect to the number of employees, apparel manufacturers comprising 5~19 employees were performed the least frequently worker centered system, while those comprising 50~99 and 100~299 employees the least frequently worker centered system.

Key words : management centered system, product centered system, worker centered system, manager centered group, product centered group.

I. Introduction

The apparel manufacturing has been considered as highly social situation sensitive industry. Being a final stage of whole apparel manufacturing process in textile industry in which a product is to be completed, it must

be one of the highly value additive one.

The domestic apparel manufacturers have successively gone through for decades just by integrating OEM (Original Equipment Manufacturing) and easily available labors which has been cheap and abundant. This kind of production system - mass production and OEM-has developed based on the low produc-

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tion cost. However, the late 80's experienced the shortage of labors accompanied by the remarkable increment in labor cost. It meant that the tradition production system could not work properly any more.

Therefore, new production systems have been employed. Firstly, the traditional production system has been replaced with outsourcing to sub-contractors. Second, the manufacturers moved to overseas to maintain their competitive edge-low cost. Recently, the 80~90 percent of apparel production is executed by outsourcing. Admitting that the sub-contractors have made a progress in terms of their managing systems, they must be far away from an efficient apparel production system. Most of them are very small and very weak in financial sustainability.

On the other hand, in spite of being expected type of many kinds and small volume in production as environments have been changed, mass production is still dominated in apparel manufacture. Here, we may admit that there were a few progresses in production systems in that the manufacturers have adapted themselves to be specialized in a few kinds of production.¹⁾ Since the progress has been insignificant, the current apparel production system needs more improvement.

In Korean researcher group, that kind of discussion is in its beginning stage. Jo(1994)²⁾ gave his main attention to figuring out the balanced scheduling in progress of apparel production system, while Ministry of Trade

& Sewing Science Research Institute(1995)³⁾ and Kim(1996)⁴⁾ tried to establish a standardized time by investigating activities in progress of apparel production. On the other hands, Choi(1993)⁵⁾ and Uh(1998)⁶⁾ are notable in that the former provides us with information about the current status in the automation of apparel manufacturing and the latter deals with the apparel production systems.

However, in this research area the apparel production system has received little attention. Hence, this study aims at helping the apparel manufacturers strategically in their adoption among the available production systems by 1) identify types and usage levels of production systems, 2) classify apparel manufacturers based on production systems and 3) investigate relationship between characteristics of apparel manufacturers and production system. Apparel manufacturer's characteristics included major product line and the number of employees.

II. Research Method

1. Research Problem

In order to achieve the research goals, research problems are proposed.

- 1) In which dimension and usage level are the production system employed in apparel manufacture?
- 2) What kinds of types are there in the production systems employed in apparel manufacture?

¹⁾ Korea Textiles Industry Association, *Textiles Yearbook* (1997).

²⁾ Ho-Hyun Jo, A Study on the Line Balancing for Productivity Improvement of Knit Shirts's Manufacturing Process. Inha University. Unpublished Doctoral Dissertation (1994).

³⁾ Ministry of Trade & Sewing Science Research Institute, 1995. *Manufacturing Technical Standard Book of Clothing & Textiles Products*.

⁴⁾ Ok-Kyung Kim, A Study on the Method and Work Measurement for Productivity Improvement of Clothing Products-Centering MTM Analysis-. Sungshin Woman's University. Unpublished Doctoral Dissertatoin (1998).

⁵⁾ Jeong-Wook Choi, A Study on the Usage of Apparel CAD Systems, Ewha Women's University. Unpublished Master's thesis (1993).

⁶⁾ Mi-Kyung Uh, A Study on the Reinforcement of the Apparel and Needlework Business in Korea -Focused on their Production Systems-. Sookmyung Women's University. Unpublished Master's Thesis (1997).

- 3) Is there any difference in production system in terms of the characteristics of apparel manufacturers such as product line and size of firm?

The operational definitions for this study are provided as follows:

1) Production system

The structure of process through which a product is manufactured. The production system comprises three factors such as process management, product process and worker's role. The production system can be recognized of management centered system, product centered system and worker centered system based on usage level of three factors.

2) Management centered system

Manufacturing structure which operate in the higher level of systematization and control of process

3) Product centered system

Manufacturing structure which operate in the higher level of style change

4) Worker centered system

Manufacturing structure which operate in the higher level of process numbers of worker

2. Research Method

The 215 factories were randomly selected among the apparel manufacturers for domestic distribution located in Seoul and Kyung-gi region. A questionnaire was pilot tested for content validity and instrument reliability, and the revised questionnaire was used to survey plant managers. The survey was done from 2/21/1998 to 3/14/1998. The president and/or supervisors were interviewed on the spot and the results were recorded in the form of questionnaires. Discarding the incomplete questionnaires (14 sheets), the data from the other complete questionnaires (201 sheets) was statistically processed and then analyzed.

<Table 1> Profile of respondent companies

Section		N(%)
Product line	Men's wear	18(9.0)
	Women's wear	127(63.2)
	Casual wear	26(12.9)
	Knit wear	28(13.9)
	Did not answer	2(1.0)
	Total	201(100.0)
Number of employees	5 to 19	66(32.8)
	20 to 49	107(53.2)
	50 to 99	19(9.5)
	100 to 299	8(4.0)
	Did not answer	1(.5)
	Total	201(100.0)
Number of items	1	74(37.2)
	2	27(13.4)
	3	24(11.9)
	4	28(13.9)
	5	21(10.4)
	6	12(6.0)
	7 over	14(7.0)
	Did not answer	1(.5)
	Total	201(100.0)
Types of firm	Planning & Production	45(22.5)
	Production only	153(76.1)
	The others	3(1.5)
	Total	201(100.0)
Production volume of style	Under 99 pieces	20(10.0)
	100 to 199 pieces	49(24.4)
	200 to 299 pieces	34(16.9)
	300 to 499 pieces	43(21.3)
	500 pieces over	41(20.4)
	Did not answer	14(7.0)
	Total	201(100.0)
'95 Sales volume(won)	Under 5M	54(26.9)
	5.1M to 10 M	53(26.4)
	10.1M to 30 M	24(11.9)
	30.1M to 50 M	9(4.5)
	50.1 M over	7(3.5)
	Did not answer	54(26.9)
	Total	201(100.0)

The <Table 1> shows the profile of the interviewed companies.

3. Instrument

The questionnaire is composed of 16 questions which comprise the two distinct groups of questions such as questions about the production system and the characteristics of the manufacturers. Because the production system, as can be known from the existing research, is mainly composed of product and process, most of the questions in the questionnaire are appropriated from Lin's⁷ research and modified to fit the current status of apparel industry in Korea. Two questions about characteristics of a product, one questions about production process and five questions about systematization of process were measured on likert scales.

The pilot tests revealed that questions about the amount of production and the skill level of the workers are not relevant and therefore, discarded. As can be seen in the <Table 2>, the production system contains three inner dimensions and their distribution rate was 62.8 %. The interrelationship be-

tween factors and variables based on factor loading shows that the factor1 is responsible for the systematization of process related questions, factor 2 for the characteristics of a product related questions and the factor 3 for the number of processes which a worker should deal with. From this analysis, the factor 1, 2 and 3 were respectively nominated as the management centered system, the product centered system, and the workers centered system.

4. Analysis

Data were analyzed by using factor analysis, descriptive statistics, cluster analysis, discriminant analysis, and multivariate analysis of variance(MANOVA).

III. Results and Discussions

1. The Usage Levels of the Production Systems

As can be seen in the <Table 3>, the means of the factors related to the production systems - the management centered system, the product centered system and

<Table 2> Factors of production system

Item of production system	Factor ¹ management Centered S.	Factor ² product Centered S.	Factor ³ worker Centered S.
Progress supervision of work	.7788	-.0047	-.0904
Proposing alternative way of process	.7702	-.0010	.1128
Comparison of plan and real work	.7537	-.0368	.0748
Immediate control over the accidents	.7033	.1344	-.0595
Data filing	.5499	.1838	-.3660
Extent of style change	.0136	.8842	-.0051
Frequency of style change	.0826	.8719	.0979
Process number of worker	.0692	-.1089	.8952
Eigenvalue	3.0291	1.5690	1.0529
Percent of variance(%)	33.7	17.4	11.7
Cumulative percent of variance(%)	33.7	51.1	62.8

⁷ S. H. Lin, D. H. Kincade, and C. Warfield. 1995. An Analysis of Sewing Systems with a Focus on Alabama Apparel Producers. *Clothing and Textiles Research Journal* 13, 1(1995): 30-36.

<Table 3> Mean scores of production system factors

Item of production system		Mean scores(S,D)	Total mean scores(S,D)
Management <i>Centered S.</i>	Progress supervision of work	3.87(.91)	3.86(.64)
	Proposing alternative way of process	4.02(.86)	
	Comparison of plan and real work	3.82(.85)	
	Immediate control over the accidents	4.27(.81)	
	Data filing	3.30(1.14)	
Product <i>Centered S.</i>	Extent of style change	3.48(1.01)	3.32(.92)
	Frequency of style change	3.17(1.08)	
Worker <i>Centered S.</i>	Process number of worker	3.26(1.72)	3.26(1.72)

the worker centered system-are 3.86, 3.32 and 3.26 respectively.

Among the questions about the management centered system, the question about immediate control over the accidents is 4.27 and proposing alternative way of process is 4.02. This result revealed that these two items are well performed. Except the question about data filing which is 3.30, all the other ones are higher than 3.5. For the fact that the items related data filing is the lowest one, it may be reasonable to argue that in domestic clothes and textiles industry, the line managers and the technicians are responsible for running the production systems and they are not accustomed to filing data systematically.

Among the questions about the product centered system, the extent of style change is 3.48 and the frequency of style change is 3.17. This means that the values are higher than averages and hence we can safely maintain that the production system works mainly for the products which have a wide range of style variation.

Among the questions about the worker centered system, the number of the production processes is 3.26. This is notable because it increased compared to mass production system in which a worker is mainly responsible for only one process.

2. The Classification of the Apparel Manufacturers

The cluster analysis was executed in order to classify the apparel manufacturers according to the factor score. A discriminant analysis was done in order to test that there is a distinguishable identity among the production groups which were classified through the cluster analysis. Hence, a meaningful discriminant function was induced and its matching rate was 100.00%.

As can be known from the <Table 4> which contains the results of the classification and analysis of the production system based on the group analysis using factor scores, the

<Table 4> Cluster analysis by production system factors

	Factor 1 management <i>Centered S.</i>	Factor 2 product <i>Centered S.</i>	Factor 3 worker <i>Centered S.</i>
Group 1 (N= 95)	.5796 (.7093)	-.5882 (.8585)	-.2519 (.9854)
Group 2 (N=104)	-.5295 (.9327)	.5373 (.7993)	.2296 (.9614)
F	87.892***	91.715***	12.154***

*** p<.001.

factor 1 of the production group 1 is positive value(0.5796) while the factor 2 and the factor 3 are negative values. From this, we can argue that the management centered system could be the dominant one, while the other systems do not play an important role through the whole process. According to this analysis, the production group 1 was titled by managers centered group. Analysis revealed that the production group 2 is different from the production group 1. In the case of the production group 2, the factor 2 (0.5373) was the highest one and the factor 3 (0.2298) was the second one as positive values. From this analysis, the production group 2 was titled by product centered group.

The statistics shows that the managers centered group takes 47.7 % (95 out of 201) and the product centered group takes 52.3 % (104 out of 201). For the manufacturers that can be classified into the managers centered group, the mid-level managers play a major role, focusing on the systematization of the process. Meanwhile the product centered groups are operated mainly around the characteristics and the number of the processes that a worker is responsible for.

3. The Production System and the Characteristics of the Manufacturers

1) The production system and the product line

The <Table 5> shows the result of the MANOVA to investigate the interrelationship

between the product line and the production system. In the case of the men's wear, the differences between the production systems were very significant (Hotelling's $T^2 = .9271$, $p < .05$). The management centered system got the highest point and the product centered system and the workers centered system took the second and the third respectively. The discernible ability between the production systems stems from the fact that the worker centered system was performed in least level ($F = 12.8878$, $p < 0.01$).

In the case of the women's wear, the factors were significant (Hotelling's $T^2 = .1006$, $p < .01$). The worker centered system played a critical role in increasing the discernible ability ($F = 9.6506$, $p < .01$). The worker centered system took the top rank and the management centered system and the product centered system took the second and the third.

In the case of the knit wear, the factors were significant (Hotelling's $T^2 = .9651$, $p < .001$). The discern-ability was dependent upon the management centered system ($F = 5.5889$, $p < .05$.) and the worker centered system ($F = 5.7647$, $p < .05$). In terms of the level of the performance, the product centered system, the worker centered system and the management centered system are in order.

<Table 5> Relationship between production system and product line

	Management Centered S.	Product Centered S.	Worker Centered S.	Hotelling's T^2
Men's wear	.1914	-.2319	-.6864*	.9271*
Women's wear	.1293	.0900	.2720**	.1006**
Casual wear	-.1853	-.1049	-.4229	.3581
Knit wear	-.5191*	-.1862	-.3878*	.9651***

* $p < .05$, ** $p < .01$, *** $p < .001$.

<Table 6> Relationship between production system and firm size

	Management <i>Centered S.</i>	Product <i>Centered S.</i>	Worker <i>Centered S.</i>	Hotelling's T ²
5~ 19 employees	-.2773*	-.0200	.3874**	.2878***
20~ 49 employees	.1631	.0910	-.0500	.0409
50~ 99 employees	.0820	-.1964	-.7675*	1.1011**
100~299 employees	.1292	-.4185	-.7286**	4.6459*

* $p < .05$, ** $p < .01$, *** $p < .001$.

2) The production system and the firm size

The <Table 6> shows the result of the MANOVA to investigate the interrelationship between the production system and firm size. In the case of the 5~19 sized factories, the factors were significant (Hotelling's $T^2 = .2878$, $p < .001$). The management centered system ($F = 4.7075$, $p < .05$) and the worker centered system ($F = 10.4064$, $p < .01$) influenced the discernible ability. In terms of the level of the performance, the worker centered system, the product centered system and the management centered system are in order.

In the case of the 50~99 sized factories, the factors were significant (Hotelling's $T^2 = 1.1011$, $p < .01$). The worker centered system influenced the discernible ability ($F = 19.3985$, $p < .05$). In terms of the level of the performance, the management centered system, the product centered system and the worker centered system are in order.

In the case of 100~299 sized factories, the factors were significant (Hotelling's $T^2 = 4.6459$, $p < .05$). The worker centered system influenced the discernible ability ($F = 22.1251$, $p < .01$). In terms of the level of the performance, the management centered system, the product centered system and the worker centered system are in order.

IV. Conclusions

The purpose of this study were to 1) identify types and usage levels of production systems, 2) classify apparel manufacturers based on production systems and 3) investigate relationship between characteristics of apparel manufacturers and production system. For this study, the questionnaires were administered to 215 apparel manufacturers in metropolitan area from Feb. to Mar. 1998. The owners or the managers of the plant were asked to fill out the questionnaire. Employing a sample of 201, data were analyzed by using factor analysis, descriptive statistics, cluster analysis, discriminant analysis and MANOVA.

The following are the results of this study:

1. The production system was identified as three types of production system such as the management centered system, the product centered system and the worker centered system. Apparel manufacturers were operated frequently the management centered system. This shows that the management centered system is efficiently performed compared to the other two production systems. The discussion reveals that mid-level managers who are responsible for the management centered system play the most important role in the production process. On the other hand, it is reported that the mid-level

managers must be responsible for the low efficiency especially in production efficiency.⁸⁾ Therefore, it is arguable that it is necessary to train and encourage the mid-level managers for the purpose of enhancing the efficiency of the production systems and production efficiency.

2. Based on three types of the production system, apparel manufacturers were classified into manager centered and product centered groups. For the manufacturers that can be classified into the managers centered group, the mid-level managers play a major role, focusing on the systematization of the process. Meanwhile the product centered groups are operated mainly around the characteristics and the number of the processes that a worker is responsible for. The classified group appeared almost equal size respectively.
3. With respect to major product line, the analysis shows that there is a tight relationship between the kinds of products and the production systems and also that the worker centered system played the major role for all of the three production systems. It is notable that even though the men's wear and the women's wear share the worker centered system as the main factor, its influences are very opposite. The worker centered system was the lowest one for the men's wear, whereas the highest for the women's wear. It is possible to explain the difference in such a way that in the case of the women's wear, a worker is responsible for a number of processes at once.

With respect to the number of employees, there were significant differences between production systems. Apparel manufacturers comprising 5~19 employees were performed the most frequently worker centered system,

while those comprising 50~99 and 100~299 employees the least frequently worker centered system. The small size of apparel manufacturers were operated based on worker's role, while the big size of apparel manufacturers were operated based on plant manager's role. From the discussion executed above, we can conclude that the small-sized factories are skill-dependent, while the large-sized emphasize the systematization of the process by the mid-level managers.

The results of this study could be used for Korean apparel manufacturers to seek the primary data for production systems.

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⁸ Korea Textiles Newspaper. '97 Textiles Fashion Yearbook. (1997), 1228-1230.

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