



## IMPACT OF LEAGILE MANUFACTURING SYSTEM ON INDUSTRIAL UP-GRADATION OF APPAREL INDUSTRY OF BANGLADESH

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### ABSTRACT

*In the manufacturing step of the global apparel value chain (GAVC) the firms face fierce competition due to availability of low cost labor and hence the opportunity to make higher profit is a tough job. A good strategy to overcome this problem is industrial up-gradation through value chain. Resource based view can be an important logic to advocate that leagile (lean and agile) manufacturing system can be a unique resource for the firm and can facilitate a firm for doing that up-gradation. This study has done a survey on 180 apparel firms in Bangladesh and by using structural equation modeling it found that human resource aspect of leagile manufacturing system positively influences production aspect of leagile manufacturing system and production aspect of leagile manufacturing system positively influences on industrial up-gradation and eventually on firm performance. The construct of production aspect of leagile manufacturing system shows that the variables responsible for producing fashionable products are influencing industrial up-gradation. But some of the characteristics of leagile manufacturing are not having impact on industrial up-gradation in an unidirectional way. Therefore, the study concludes that although all the characteristics of leagile system are not uni-directionally influencing on industrial up-gradation, leagile system even if it is fractional, is positively influencing on industrial up-gradation.*

**Key Words:** Industrial up-gradation, Leagile, resource based view, Value chain, Vertical integration.

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## INTRODUCTION

The value chain of apparel industry is widely spread throughout the world. Since 1980s, the value chain of apparel business have been divided into five separate but interrelated networks such as the raw materials network, component network, production network, export network and marketing network (Gereffi, 1999). In the step of production network, the developing countries (DCs) and least developed countries (LDCs) cannot make sufficient profit because of low value addition provision. These countries face fierce competition among themselves because of availability of low cost labor in these countries (Porter, 1990). On the other hand, in the step of marketing network a firm needs to invest a lot, which is not suitable for the firms of DCs and LDCs. Therefore, very often the marketing firms in developed countries put stringent conditions of low production cost on the manufacturing firms in DCs and LDCs. Eventually, these countries are very often locked into low value adding activities and cannot strive for further industrialization. To overcome this problem, some of the firms in DCs and LDCs are trying to develop their resources and capabilities to extend their business into relevant businesses of the same value chain like design making, procurement, logistics and marketing and distribution etc. This is not an easy way to do. They have to utilize their resources and capabilities in such a dynamic way, that they can enhance the firms' performance by positioning themselves in supply chain strategically. Manufacturing system especially leagile (lean and agile) manufacturing systems can be expected to be a dynamic system by which the firms may in course of time be able to extend their activities through the value chain for becoming more competitive.

### **The Competition in the Apparel Value Chain**

It is already discussed that countries with different economic status enjoy competitive advantages in different position in the value chain and accordingly Bangladesh has competitive advantage in manufacturing stage of the value chain. But this competitive advantage is due to low labor cost and many countries in Asia, Africa and Caribbean region are ready to offer low labor cost (Grunsvan and Smakmen, 2002; Gereffi, 1999). There are many other issues which are responsible for making the market extremely competitive for Bangladeshi apparel manufacturers. For example, due to world politics United States of America (USA) and European Union (EU) favor different countries in different time. African Growth and Opportunity Act (AGOA) is that kind of favor. Geographical distance with US and EU, fast fashion fever, competition among the supply chain rather than individual firms are also important causes for making the industry highly competitive. Therefore, Bangladeshi apparel firms have to bring a change in their corporate, business or functional level strategy.

### **Industrial Up-gradation as the Strategy in Apparel Value Chain**

By analyzing the trajectories of garment industries of Hong Kong, Taiwan, South Korea and China, it was found that the key to success of East Asian firms in developing a strong position in the global apparel value chain (GAVC) was to upgrade from mere assembly manufacturing to cutting-

making-trimming (CMT) to full package supplier or original equipment manufacturer (OEM). Subsequently, firms in the East Asian NIEs pushed beyond this to develop their own design capabilities (original design manufacturers or ODM) or even the production and marketing of their own brands (Original Brand Manufacturers or OBM) (Gereffi, 1999), thus becoming more independent from buyers and repositioning themselves in the chain. The reason behind this type of strategy regarding up-gradation in value chain is that apparel market is buyer driven chain not a producer driven chain like automobile market. The producer has to advance on the basis of both their resources and capabilities as apparel manufacturing is not capital and technology intensive and the manufacturers do not have much bargaining power in the negotiation with the buyers. The up-gradation stages are: a) from CM/CMT to OEM b) from OEM to ODM and c) from ODM to OBM. According to Gereffi (1994) CMT means cutting, making and trimming. Here the garment manufacture receives all the raw materials including fabrics and also it receives all types of logistical supports for exporting back to the buyer's specified destination. The up-gradation from CMT to OEM happens when firms soon become full-range package suppliers for foreign buyers and develop an innovative entrepreneurial capability that involves the coordination of commercial activities like procurement and all sorts of logistics, marketing and distribution activities. In ODM production process, the firms apart from OEM activities, develop a design studio. After negotiation with the buyers the firms finalize the design for the buyers at their own design studios. But they do not have their own brand. These types of firms can make the lead time shorter. After a lot of experience as OEM and ODM, finally some firms can establish their own brands and become OBM, although these types of firms are still very rare in DCs and LDCs. This type of strategy has mainly two advantages: one is increasing the opportunity to add value in per piece of product and therefore making more profit and the other is increasing the influence of the firm in the supply chain and therefore pooling the negotiation power (Porter, 1990; Sehgal, 2011). Industrial up-gradation strategy does not mean that the firms have to advance step by step. Very often the firms can undertake procuring, designing or marketing activities at the same time at different degree on the basis of their capabilities (Rahman et al., 2008). On the contrary, industrial up-gradation may be a risky venture if the firms do not have enough capacity and proper knowledge for running the new businesses. Moreover, it may increase production cost in CMT if adjustment is not properly made among all the value adding steps.

### **The strategy option for Bangladesh**

Bangladesh should follow the same path of industrial up-gradation of East Asian nations. The East Asian nations did not achieve this path all on a sudden. They improved their manufacturing system day by day. They gradually introduced many cutting edge technologies like Computer Aided Design (CAD), Computer Aided Manufacturing (CAM) and Enterprise Resource Planning (ERP) etc. and therefore, could pursue industrial up-gradation strategy. Bangladeshi firms are also adopting the modern technology gradually as the firms here, have been successfully fighting the battle for more than three decades. In course of time, the industry gained much of its knowledge from South Korean apparel and textile experts (Rhee, 1990). Later, the entrepreneurs in Bangladesh

earned much of their knowledge from their buyers in USA and EU which happened through negotiation on maintaining stringent compliances. For example, simultaneously controlling quality and cost hatched the innovation of many of lean and agile manufacturing techniques which are not exactly similar to those of Japan but underpinned the same philosophy. For the last three decades through an evolutionary process, the entrepreneurs have realized the importance of strategic manufacturing and hence two top associations of Bangladesh apparel firms, Bangladesh Garments Manufacturers and Exporters Association (BGMEA) and Bangladesh Knitwear Manufacturers and Exporters Association (BKMEA) launched several programs on establishing lean manufacturing system (BKMEA Manual, 2008). So the advancement in manufacturing technology may hatch for industrial up-gradation in Bangladesh which reminisce the success of East Asian nations.

In the part of literature review (the second part) the study will show logical relation between leagile manufacturing system and industrial up-gradation. Here the resource based view is an important view point. In the third part the study discusses research methodology on the basis of structural equation modeling and in the fourth part it analyses the result. In the fifth, sixth and seventh part the implications of the study, future research direction and conclusion are respectively presented.

## **LITERATURE REVIEW**

### **Leagile Manufacturing System in Bangladesh Apparel Sector**

Leagile manufacturing system is the combination of lean and agile manufacturing system. In comparison to mass production system, leagile manufacturing system is expected to work better in favor of Bangladesh apparel sector. The reason for this is that, it facilitates both customization and cost reduction (Gunasekaran, 2002). Lean manufacturing system is a production initiative whose goal is to reduce the waste in human effort, inventory, time to market and manufacturing space to become highly responsive to customer demand while producing world class quality products in the most efficient and economic manner (Todd, 2000). The concept of lean manufacturing is an offshoot of the “Time and Motion” study of Frederick Taylor which dates back to 1890. Following Taylor’s underpinning in 1910, Henry Ford invented the assembly line for his standardized Ford Model T. After the Second World War, Taichi Ohno and Shigeo Shingo of Toyota propounded the idea of just-in-time (JIT) or Kanban, waste reduction, continuous improvement (Kaizen) and pull system which in together with other aspects of Japanese factories became a popular manufacturing system named as lean manufacturing system (Naylor et al., 1999). Some other very important focuses of lean manufacturing can be understood by 5s (sort, set in order, shine, standardize and sustain). Lean manufacturing is therefore focused on getting the right things to the right place at the right time in the right quantity to achieve the perfect work flow, while minimizing the waste, being flexible and able to change through maintenance of level schedule. On the other hand agile manufacturing system is little more advanced manufacturing system which has many of the characteristics of lean but able to response quickly to the fast changing fashion world. As opposed to lean manufacturing system (high volume/low mix), agile manufacturing system possesses the

characteristic of low volume/high mix. In the corporate mission of vertical integration, both the characteristics of lean like time compression, reduction in wastage, advantage of flexibility, cost reduction, quality improvement and the characteristics of agile like customization, product differentiation and re-configurability/quick changeover (also characteristics of lean manufacturing) are motivating factors. In combination of lean and agile system it becomes leagile and it can be pursued if the firms have quite a good amount of experience in manufacturing and ability to combine some production lines based on lean and some production lines based on agile (Krishnamurthy, 2007).

Unlike mass production system leagile manufacturing system can be designed to maximize all the performance criteria like cost, quality, flexibility and dependability simultaneously. Because of economies of scope all the performance criteria become complimentary for each other in leagile manufacturing system. For example, flexibility gives opportunity for product variety with broader range and product variety gives the opportunity for economies of scope. Therefore, economies of scope along with multitasking and just in time management gives the business better production frontier (Hayes and Pisano, 1996).

### **Two Dimensions of Leagile Manufacturing System**

Leagile manufacturing system should not be viewed only as a coordinating activity among the productions aspects. It has a philosophical aspect which gives the organization a particular human resource dimension and a production dimension (Ward and Zhou, 2006).

### **Human Resource Aspect of Leagile Manufacturing System**

An empirical study, done by Jayaram (1999) on 57 North American firms, showed that strategy-specific Human Resource Management (HRM) 'bundle' rather than a generic HRM initiative has a high impact on its corresponding dimension of manufacturing performance. Consequently, leagile manufacturing must need to tailor its' required bundle of human resource traits (Forester, 1995). If we go back to the evolution of lean and agile manufacturing system, we see that Japanese managers of Toyota did not accept all the suggestion from the U.S mentors after the World War II. They rejected the American Ford practice of having specialized jobs for factory workers and poor treatment with them. Instead, they trained and empowered the workers sufficiently (Dagher, 2008). They promulgated the system of multi-skilling, work rotation, problem solving discussion group for better idea generation etc. Dibia & Onuh (2010) and Boudreau et al. (2002) stated that lean manufacturing system surrounds such a managerial philosophy where the participants in the system have to be motivated by training, commitment, empowerment or any other zeal and interest. Dagher (2008) stated the determinants of human resource aspect of leagile system are currently in practice in Bangladesh. These are training of workers, empowerment of workers, mastership, commitment of workers, multi-skilling, work rotation.

### **Production Aspect of Leagile Manufacturing Aspect**

Production aspect of leagile system means the activities about machinery, technology and process. These determinants of production aspect of leagile manufacturing system are: JIT for minimum inventory management, waste minimization, continuous improvement, quick changeover, quick response system (QR), product variety, customization and product differentiation (Dagher, 2008).

### **Industrial Up-gradation**

Gereffi's (1999) explanation of industrial up-gradation into branding, design making, commercial activities especially procurement, logistics function and marketing and distribution can be viewed as vertical integration from the view point of corporate strategy defined by Porter (1990). If CMT firms integrate themselves to design making, logistics or procurement functions, it means that the firms have increased their scopes of doing business towards up-stream and down-stream. The concept of vertical integration, value chain integration and Gereffi's industrial up-gradation in apparel industry are same phenomena. The determinants of industrial up-gradation are design making activities, logistics and marketing and distribution activities.

### **Firm Performance**

From a financial perspective, the keys to long-term success of any business are earnings behavior (the ability to generate income) and savings behavior (the ability to retain earned income and reinvest it in the business). Thus, the higher the income-generating capacity of the firm business, and the larger the proportion of that income that is ploughed back into the business, the higher the sustainable growth rate (Miller et al., 2001). Here in this study Return on Asset (ROA), capital growth, profit growths are the indicators of firm's financial performance. Another very important indicator for firm performance is schedule performance (Chua et al., 1999). Schedule performance means managing the lead times for different orders of different destinations prudently. This schedule performance has become one of the key indicators of competitiveness for apparel firms throughout the world (Rahman et al., 2008) due to fast fashion fever and differing geographical distances from US and EU to different supplying countries.

### **Impact of Human Resource Aspect to Production Aspect of Leagile Manufacturing System**

According to Dibia and Onuh (2010), lean manufacturing is a socio-technical system and it clearly views people as a resource to be developed. They also stated that one of the important reasons for failure of lean manufacturing system in USA in 1970s is not to take the concern about human intelligence. By doing an exploratory study they showed that a lean organization needs broad, continuously trained, intelligent and self reinforcing workers prior to establishing automation and technological up-gradation. According to Bourdreau et al., (2002), without motivation in workers the firms loss many opportunities in operations. In apparel firms lean and agile both requires intelligent application of available technologies for reducing waste, enhancing flexibility, customization or product variety. Continuous improvement is a matter of inner aspiration of

workers to innovate new system. Therefore, human resource aspect of leagile system positively influenced production aspect of leagile system.

### **Impact of Production Aspect of Leagile Manufacturing System on Industrial Up-gradation**

Manufacturing system is the strategic application of production technologies on the basis of nature of market demand and firm's available human resources and technologies (Gunasekaran 2002). Skinner (1969) and his disciple Wheelwright (1978) pioneered the idea that manufacturing strategy must have to be aligned with corporate strategy due to rising global competition in the international trade. Wheelwright elaborated that same functional manufacturing strategy can be shared in corporate wide. According to Gunasekaran (2002) leagile manufacturing system obtains various dimensions of performance like both customization and high volume. Therefore, there may be some common elements in functional manufacturing strategy of leagile system which can be shared in the extended line of businesses. It means in leagile system, functional manufacturing strategy may be extended into corporate manufacturing strategy. Consequently, in apparel sector of Bangladesh by adopting leagile manufacturing system industrial up-gradation is possible.

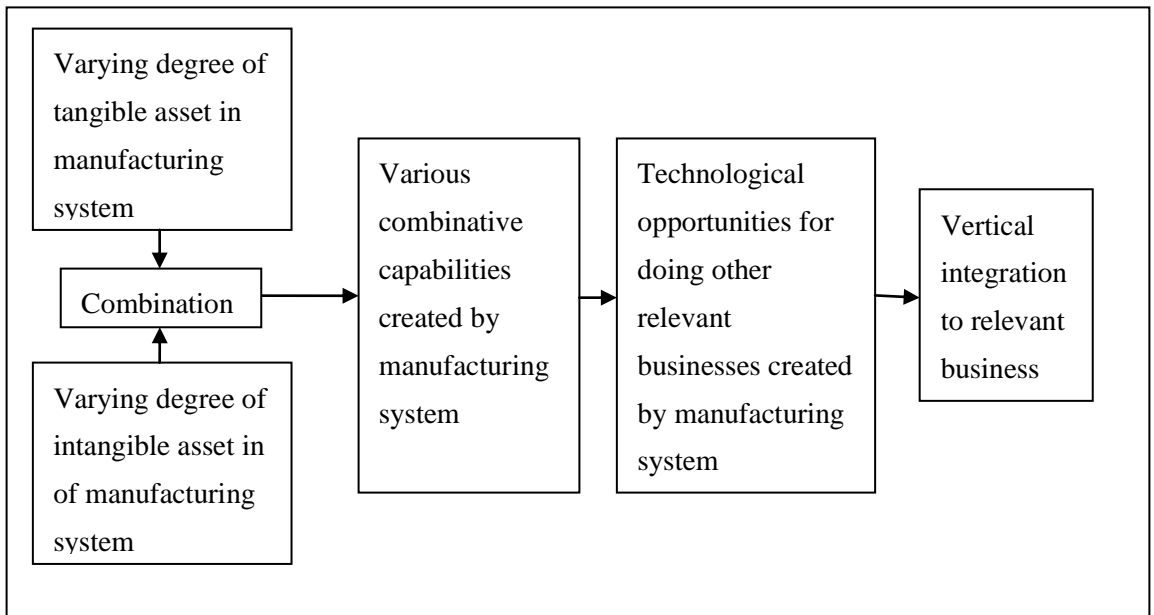
In an empirical study Sun and Hong (2002) showed that if manufacturing strategy and corporate strategy are aligned to each other, the business performances like on-time delivery, inventory turnover, market share and profitability can be improved. In a case based study Riis (1992) showed that while devising manufacturing strategy, product design and assembly concept should be developed concurrently. In apparel sector, if the firms want to engage in the design of the product they obviously have to go for vertical integration as discussed earlier. So in case of apparel sector, there is good possibility that devising a manufacturing strategy will invite the issues of vertical integration.

### **Resource Based View (RBV) and Production Aspect of Leagile Manufacturing System's Impact on Industrial Up-gradation**

The fundamental principle of the RBV is that the firm sustains in the market because of its resources are valuable, in-imitable, rare and not substitutable (Wernerfelt, 1984; Rumelt, 1984). From RBV perspective firms are heterogeneous, knowledge bearing entities and their performance depends on using asymmetries in knowledge and uniqueness in capabilities (Conner and Prahalad, 1996). In the same way, Kogut and Zander (1992) argued that firms exist because they have higher order organizing principles that market cannot offer. Such higher order organizing principles give the firm different combinative capabilities and hence firms with dynamic manufacturing system get many technological opportunities by articulating technologies into a language accessible to a wider range of value adding activities. Production under leagile manufacturing system is so dynamic that it can generate combinative capabilities by combining firm's own tangible and intangible asset (Porter et. al, 2000; Nonaka and Takeuchi, 1995; Nonaka, 1994). For example flexible manufacturing and customization under leagile production system are able to blend modern

hardware and software technologies in varying degree. The ability to utilize different blend of these technologies develop technological entrepreneurship in the owners and managers and therefore become able to vertically integrate the firm's business (*see figure 1*). In the same way technological entrepreneurship can be developed if the firm strives to extend its production line or try to invent new process which can reduce waste.

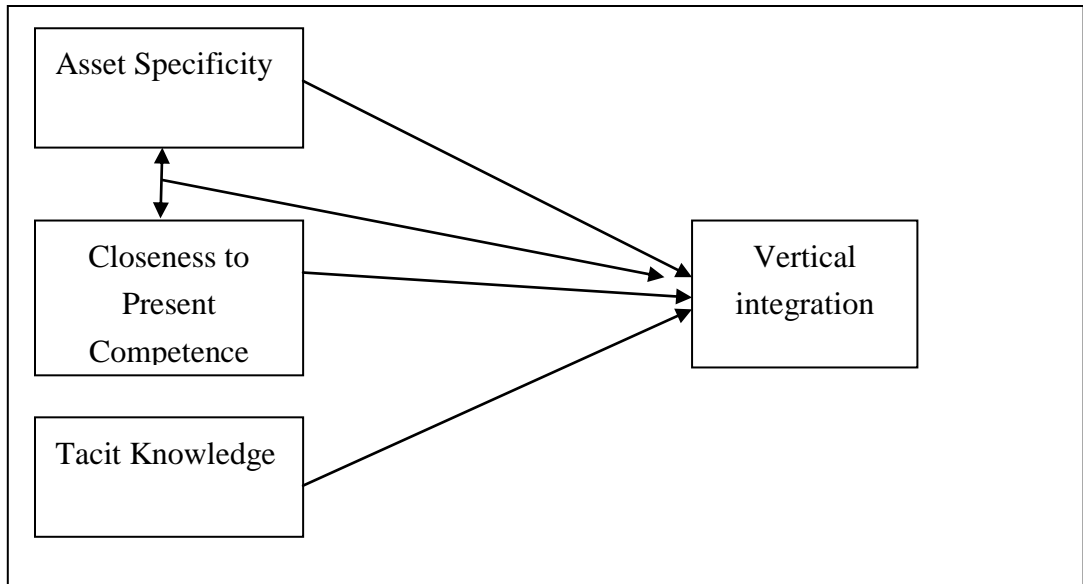
**Figure-1.** Utilizing tangible and intangible assets for vertical integration



**Source:** the author

By the principle of continuous improvement a firm with leagile system tailors its own resources and knowledge which can decode the asset specificity of the relevant businesses in the same value chain. Mahoney and Pandian (1992) said that firm's resources which can continuously improve the rent seeking activity is able to diversify the firm's business. Gulbrandsen (2009), found the same type of result by doing an empirical study done on 411 business units. He showed that asset specificity and its closeness to its present competence and its ability to decoding tacit knowledge are positively related to firm's vertical integration (*see figure 2*). In this study, asset specificity in CMT has closeness to designing, logistics and marketing activities as all are done with ERP software, QR software and many other automated machinery and on the other hand lean manufacturing have the ability to decode tacit knowledge (Porter et. al, 2000; Nonaka and Takeuchi, 1995). Therefore, leagile manufacturing can be deemed as an asset for the firm and it can positively influence in favor of vertical integration. In another empirical study done on 344 firms, based on RBV, Silverman (1999) showed that a firm can diversify into the relevant businesses if its existing technological resources are applicable to relevant businesses.



**Figure-2.** Relation of asset specificity and tacit knowledge to vertical integration

**Source:** Modified from Gulbrandsen et al. (2009)

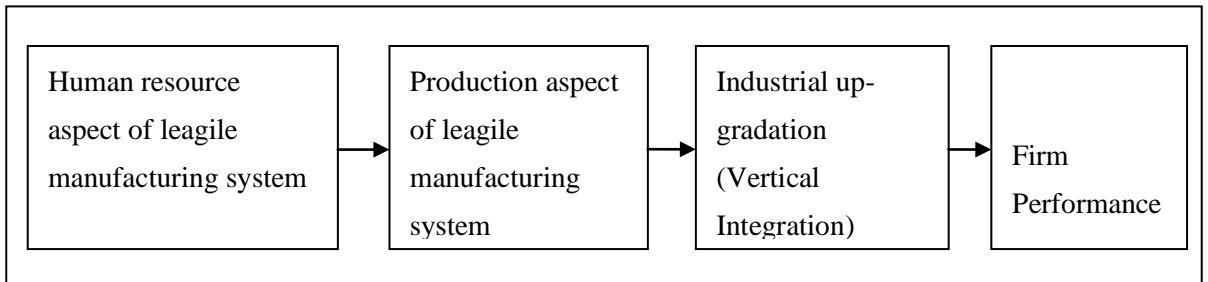
### **Influence of Industrial Up-gradation/Vertical Integration on Firm Performance**

From the viewpoint of transaction cost economics, by vertical integration the firms can reduce the risk of being held up by logistics firms, procurement firms and by the retailers who provide the designs for making the apparels. In apparel business, the held up phenomena is a common (Gereffi and Korzeniewicz, 1994). The firms involved in procurement may switch anytime to other firms. Depending on the fast changing demand, driven by the fast fashion phenomenon the procuring firms or even the retailers may become opportunistic and rent seeker. Therefore, by vertical integration the firms can overcome this risk of being held up. Moreover there are many unpredictable phenomenon may occur due to lack of information and volatility of market. By vertical integration this can be overcome. By vertical integration the firms can reduce the agency cost also. After vertical integration several relevant businesses can be monitored by single administration and also the firm gain pooled negotiation power. So cost of production is reduced.

### **Conceptual Framework**

As per the above discussion, although there are empirical studies on relation between manufacturing strategy and corporate strategy and the relation between RBV and vertical integration, there is no empirical study on relation between manufacturing strategy particularly leagile system and corporate strategy particularly vertical integration and subsequently relation with firm performance. This study will strive to find the impact of human resource aspect of leagile of manufacturing system on production aspect of leagile manufacturing system and the impact of

production aspect of leagile manufacturing system on industrial up-gradation and subsequently on firm performance (see figure 3).



*Hypotheses:*

*H1: The greater the firm’s initiatives for human resource aspect of leagile manufacturing system, the greater the establishment of production aspect of leagile manufacturing system*

*H2: The greater the establishment of production aspect of leagile manufacturing system the more the industrial up-gradation of the firm*

*H3: The more the industrial up-gradation of firm the better the performance of the firm*

**RESEARCH METHODOLOGY**

A questionnaire survey is implemented to collect data by Likert scale. Therefore, the collected data are perceived rather than objective. Then by using SPSS 18.0, the collected data of the observed variables are extracted as component by exploratory factor analysis (EFA) to identify the factors. Further the factors are tested against confirmatory factor analysis (CFA) by AMOS 20.0 and finally under structural equation modeling, the conceptual model was estimated by AMOS 20.0.

**Structure of the Questionnaire**

In order to collect necessary data for testing the hypothesized model, we construct a questionnaire consisting of five parts. The first part is the introductory part asking about general matters of the firm. In the second part, questions are asked about which value adding steps the firms are involved except cutting-making-trimming like designing, procuring and marketing and distribution activities. The second part and third part are consisted of the questions about the characteristics of production aspect and human resource aspect of leagile manufacturing system respectively. The fourth part is consisted of questions regarding firm performance like capital growth, profit growth, ROA, increase in the number of buyers and schedule performance etc. But during the conduct of the survey everyone could not give answers about ROA because of lack of knowledge about it and here it is to be mentioned that almost all the respondents were either production mangers or merchandisers.

## **RESPONDENT PROFILE**

The survey is conducted on 180 firms located in both EPZ and non-EPZ area. 100 firms from two EPZ area namely Dhaka EPZ and Chittagong EPZ are surveyed and rest 80 firms are surveyed in non-EPZ area like Mirpur, Gazipur and Ashulia under greater Dhaka region.

## **DATA ANALYSIS AND RESULTS**

### **Exploratory Factor Analysis (EFA)**

As per the conceptual model, this study has constructed the structure of the model consisted of four factors namely human resource aspect of leagile manufacturing system (HRLMS), production aspect of leagile manufacturing system (PLMS), industrial up-gradation (IU) and firm performance (FP). All these four factors are theoretically inter-linked according to the description of literature review of this study. Hence, we do not need to find any other relationship patterns by conducting EFA for all the variables together. Rather this study tries to check whether the variables we are going to use for each latent variable are unidirectional and able to explain the latent variable with sufficient variance. If any of the observed or manifested variables are not suitable for explaining the unobserved/ latent variable it should be eliminated from the group of the observed variables on the basis of component matrix or rotated component matrix in Principle Component Analysis (PCA). After constructing the components, if any satisfactory relation among the components are not found, reformulation by eliminating the observed variables having less standard deviation and too dispersed mean can be done (*Table-1*). The variables can be eliminated until a satisfactory value of Cronbach's Alpha is got (Blunch 2008). After reformulation the study is expected to find a satisfactory relationship among the cluster of variables.

Before doing EFA the internal consistency among the questions regarding each factor was checked by reliability test. It was done by measuring Cronbach's alpha. Cronbach's alpha for HRLMS, PLMS, IU and FP were respectively .770, .707, .701, .722 which indicate that the questions regarding each factor are unidirectional (the accepted level is .70) (Cronbach and Shavelson, 2004). Then PCA is performed in SPSS 18.0 for EFA.

**Table-1.** Variables mean and standard deviation

Variables	Mean	Std. Deviation
Design	2.2167	1.19718
Procurement	2.6167	1.20648
Marketing	2.5833	1.05107
Logistics	3.0611	1.58260
QR	2.9889	1.49109
Customization	3.0333	1.26359
Differentiation	3.0833	1.08249
Volume Flexibility	2.7833	1.07939
Product Lines	2.7278	1.06781
Quick Changeover	3.2167	1.46572
Minimum Inventory	3.6944	1.32487
Waste Minimization	4.3944	.77313
Team work	3.3667	1.18605
Multi Skilling	2.3111	1.34658
Workers Commitment	3.1444	1.23326
Workers Training	2.7556	.94911
Workers Empowerment	2.6722	1.28085
Mastership	3.8389	.96395
Standardization	3.6611	.98119
Cleanliness	4.1167	.97037
Capital Growth	2.6667	1.01387
Profit Growth	2.5500	1.03716
Schedule Performance	2.9000	1.05227
Sales Growth	2.8444	1.08737
Buyers Number	3.7556	.93128

The observed variables used for EFA for PLMS are QR, quick changeover, customization, differentiation, volume flexibility, number of product lines, JIT attempting for zero inventory, waste minimization, teamwork, multi-skilling, mastership of the seniors, standardization of production method, cleanliness-setting-sorting, workers commitment, workers empowerment, workers training etc. Out of all the variables, only customization, differentiation, JIT for minimum inventory, number of product lines and volume flexibility constructed one component and the rest are eliminated. In the EFA for HRLMS teamwork, multi-skilling, workers commitment, workers empowerment and workers training constructed one meaningful component but mastership of the seniors is eliminated. In case of IU designing, procuring and marketing and distribution activities constructed the component but logistics is eliminated. And finally for FP capital growth, profit growth and schedule performance made one construct but buyers' number is eliminated. The main reason for eliminations in all the cases is due to lack of correlation with the rest of variable or due to low factor loading. The value of Kayser-Meyer-Ohlin (KMO) test in EFA for HRLMS, PLMS, IU and FP are .741, .769, .620 and .697 respectively. The accepted level for KMO test is 0.6.

### Confirmatory Factor Analysis

After EFA, a diagram according to the conceptual framework is drawn in AMOS 20.0 and run for CFA. In CFA each item is restricted to load to pre-specified factor and items were pre-specified according to the result of EFA.

From the *table-2*, drawn below, we see that before reformulation and running modification indices, no one of the model fit statistics is good. So, reformulation process is done and modification indices are obtained. According to the suggestion of modification indices two of the error terms under the construct of PLMS are set free and the variable 'buyers number' is excluded due to its low factor loading (.34) according to reformulation process of Blunch (2008). Exclusion of buyers number is also suggested by EFA earlier.

The model fit statistics before and after running modification indices are as follows:

*Table: 2 Model Fit Statistics in CFA*

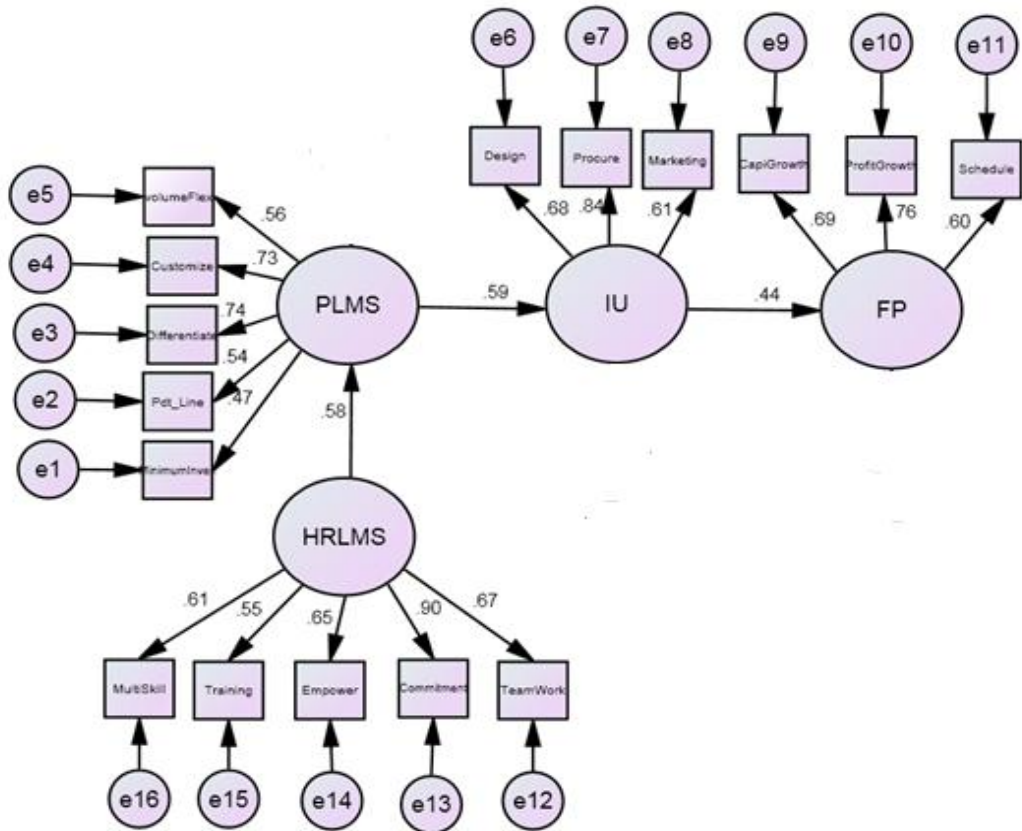
Here in *table-2*, we see that all the values of goodness of fit are good except RMSEA. But according to Schermelleh-Engel et al., (2003) RMSEA less than .05 is good and RMSEA less than .08 is acceptable. So the value of RMSEA .062 is acceptable. Before doing EFA the Cronbach's alpha is found out and in all cases the values were higher than acceptable value .70. The composite reliability of the construct is .78 (higher than expected level .70) which indicate good internal consistency and average variance extracted (AVE) is .54 (higher than accepted level .50). Convergent validity was evidenced by the significant standardized loadings of each item (.40 or higher) on its corresponding construct.

Model Indicators	Fit	GFI	AGFI	CMIN/DF	RMSEA	IFI	TLI	CFI
Good Model Fit		>.90	>.80	<3	<.05	>.90	>.90	>.90
Value in the original model		.888	.848	1.895	.071	.898	.873	.896
Value in this model after modification		.906	.870	1.680	.062	.924	.906	.923

### Sem Estimation

After CFA by AMOS 20.0 the model is estimated by same AMOS under structural equation modeling (SEM) (*see figure 3*). All the relations in the model are proved significant in the estimation having t-value less than .001 for two tailed test.

Figure-4. Diagram of structural equation modeling by AMOS20.0



## RESULTS

*From HRLMS to PLMS:* From the estimation we see that production aspect of league manufacturing system is significantly influenced by human resource aspect of league manufacturing system. Here, if the standard deviation of the later goes by 1, the standard deviation of the earlier will go by .578.

*From PLMS to IU through value chain:* IU is significantly influenced by PLMS. Here if the standard deviation of the later goes by 1, the standard deviation of the earlier will go by .591.

*From IU through value chain to FP:* FP is significantly influenced by IU through value chain. Here if the standard deviation of the later goes by 1, the standard deviation of the earlier will go by .443.

So, all the hypotheses are supported.

## ANALYSIS OF THE RESULTS

### *The relation between HRLMS to PLMS:*

All the observed variables under the construct of HRLMS are helpful for improving PLMS. Workers empowerment and commitment in together improve workers' decision making power. All these traits encourage the workers for local learning and finding out the solution for firm specific problems. Therefore, the workers become expert on many manufacturing techniques. All these tendencies develop a learning environment. These also help in establishing standardizing the production method with continuous improvement. At the same time because of these the workers can decode tacit knowledge. And explore many technological opportunities. These things help the workers for doing customization, volume flexibility and product variety. Because customization, volume flexibility and product variety depend on how the existing technologies can be utilized in different ways and how quickly the production process can be changed in the manufacturing system. Consequently, workers empowerment and commitment motivate the workers to be able for leagile related PLMS. On the other hand, training improve workers' knowledge on leagile manufacturing system. Customization, product variety, differentiation and flexibility are knowledge dependent. Therefore, training is sure to improve their knowledge on the entire production aspect. Another thing on which training should have good impact is JIT attempting for the minimum inventory. Here multi-skilling is also an indicator of HRLMS. This is also helpful for new idea generation for the workers. New idea generation is very essential for customization and product variety (Gunasekaran, 2001). These are fashion oriented and need imagination. So, all together, the HRLMS has a significant impact on PLMS. Mastership is eliminated due to having low correlation with other variables of HRLMS construct.

### *The relation from PLMS to IU through value chain:*

All the observed variables under the construct of PLMS make a meaningful relation with IU through value chain. Among the observed variables found after full process of SEM, customization and differentiation belong to the agile manufacturing system and the rests belong to both lean and agile manufacturing system. Designing is an innovation and information technology dependent activity and on the other hand customization and differentiation are also innovation and information technology based activities. Therefore, these must have impact on designing activity. Moreover as per the explanation of Nonaka (1994) multi-skilling through work rotation ploughs a good insight about the tacit knowledge of relevant businesses and leagile system gives opportunity for multi-skilling. Therefore, leagile system may help for venturing for relevant business. Leagile system develops analytical ability step by step thorough continuous improvement activities and problem solving discussion. For example, customization and differentiation develop a good idea about designing activities among the workers. In the same way as explained by Nonaka (1994), volume flexibility and increased production lines also generate wide range of idea about relevant

businesses. Volume flexibility and increased production lines creates modular production in the apparel firms (Dagher, 2008). And modular production system can make the procurement activity cost effective. Because in modular production, it needs to change production planning for various types of similar products of different design within a short period of time. Therefore, it can be easily guessed that volume flexibility and differentiation have a profound impact on developing procurement business in the firm of its own. The construct of PLMS shows that leagile attributes are responsible for producing fashion oriented buyers to be unidirectional and to have impact on industrial up-gradation.

In EFA while constructing the construct for PLMS, some of the very important indicators like standardization of production method, waste minimization, cleanliness, setting and sorting in order and mastership of the seniors were excluded in reformulation process. These observed variables had lower standard deviation and their mean values were dispersed from the median and because of these, they had low correlation with other leagile variables. And their variances and factors loading were also not sufficient to explain particular logical factor. Even though the construct for PLMS does not represent fully the concept of PLMS, it has a significant relation with industrial up-gradation. The reason for this ability to influence may be the adequacy of experience of apparel firms in apparel production.

The construct of IU with three variables designing, procurement and marketing and distribution advocate for market oriented strategy in vertical integration. The reason may be the firms' success is heavily dependent on proper segmentation in market with quick delivery. Logistics was excluded due to not being unidirectional with other observed variables. Its correlation with other indicators of IU is also poor. The reason for not having enough correlation may be the nature of operation is not relevant to other industrial up-gradation activities. For example: designing, procurement and marketing and distribution is information technology dependent and market oriented but logistics is not.

*The relation between industrial up-gradation through value chain and firm performance:*

From the result, it is seen that capital growth, profit growth and schedule performance are influenced by IU through value chain. It is well understood that vertical integration enable the firm make more revenue generation in comparison to cost incurred for doing additional businesses. And the extra revenue earned by vertical integration is ploughed back as reinvestment in the business. But EFA and CFA did not take buyers number in the construct of FP. The reason may be buyers number is firm's exogenous nature variable and number of destinations of buyers depend on the bilateral and multilateral politics. So this is not unidirectional with other observed variables.



### **Implications for Apparel Firms and Their Associations**

From the analysis it transpires that for sustaining in the international market, industrial up-gradation can be a suitable strategy and this strategy can be pursued by implementing leagile manufacturing system. Although achieving lean manufacturing system is prior condition for establishing agile manufacturing system, the firms can be benefitted if they implement agility also like customization and product differentiation. While implementing leagility the firm owners have to keep in mind that trained, empowered and committed human resource is the prior condition for leagile production in the apparel sector of Bangladesh. So the associations of apparel firms and the Government can open many other training programs for workers and also the workers should be empowered for taking innovative decision and this will enhance their commitment. From the construct of PLMS it is understandable that firms hankering for fashionable clothing market rather than traditional clothing would find leagile system influencing on industrial up-gradation. Consequently, the firm owners may think about increasing of production lines which are able to create product varieties. The machinery should be technologically up-gradated targeting for customization and flexible production system. Through industrial up-gradation the firms are expected to increase their capital growth, profit growth and schedule performance. So for the growth of the business they should go for industrial up-gradation.

### **Future Research Direction**

This study has shown how leagile manufacturing system even fractionally influences on industrial up-gradation. Therefore, another study can be done for finding out why other observed variables are not unidirectional and if they are also within the construct, whether the impact will be higher on IU or not.

This study drew relation between leagile system and corporate strategy. Therefore, some other studies can be done, whether apparel firm's business strategy/competitive strategy or functional level strategy have relations with corporate strategy and eventually with leagile manufacturing system.

### **CONCLUSION**

Gereffi (1999) stated industrial up-gradation through value chain as a business strategy for survival and sustaining growth for the apparel manufacturers and this study has striven to draw a clear picture of how to generate the internal strength through manufacturing strategy for that industrial up-gradation. This study has shown the dire importance of human resource dimension of leagile system for implementing the production aspect of the same. This study also found out that leagile system even fractionally are working out in Bangladesh for industrial up-gradation. This study tried to explain that variables of leagile, which are not only related to waste reduction and continuous improvement but also related to fashionable products are influencing on industrial up-gradation. But the owners and managers have to keep in mind that lean and agile manufacturing system

cannot be a same package for all the firms throughout the world. It differs from country to country due to different culture. And this country specificity can be a driving force for industrial up-gradation through value chain. The study reveals that Bangladeshis firms, if not fully at least potentially are able to utilize leagile manufacturing system for industrial up-gradation and able to increase firm performance.

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