

A STUDY OF THE DESIGN CHAIN PLANNING MODEL FOR THE TECHNICAL FABRIC INDUSTRY

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ABSTRACT

Efficient new product developments have been promoted in the technical fabric industry. Quickly response to market demand is an important and essential capability in the future. Collaborative design is one effective method that enables the product development design chain to achieve virtual integration. By means of IT platform, all the participants of design chain during research and development stage are integrated using Standard Operational Process that will further promote the overall design chain efficiency. The design chain operation reference model (DCOR) developed by the Supply Chain Council was applied in this research. Besides, a systematized planning model of DCOR was constructed to serve as reference collaborative design chain design. Finally, a case study will be discussed to explain how the reference model is used to enhance the usability in practice.

Keywords: Collaborative Design, Design Chain, DCOR, Technical Fabric Industry

1. INTRODUCTION

The technical fabric industry differs from conventional textile industries in which its high-level fabric merchants possess Nano-technology (Nano film stick-on) and fabric price is 3-5 times higher than regular fabrics. It brings about added values for the company. The focus of industrial development lies in technical RD and collaborative design applications.

Technical fabric design processes are initiated after ascertaining client requirements. Clients submit vogue trends, and design concepts to the core factory, which in turn engages in self-design, RD or partially subcontract to outsourcing vendors. During mutual technical collaboration, fabric collaborative design is executed. Upon completion, sample fabric is sent to client to produce a sample product. After client confirmation on the sample fabric, mass sample production, coloration and test etc. are executed. After verifying the functions and requirements, they sent to the apparel manufactory appointed by the client.

Although individual product design processes are predominated by different organizations, the design chain is like a chain which manages through organization bounds and links collaborative supply chains between organization systems [8] Meanwhile, DCOR model is a set of tools used to establish the design chain framework based on process view,

metrics and best practice. However, since this model is not mature, it doesn't apply to many studies. This study aims to conduct how to apply DCOR model in technical fabric industry. Product design processes and e-business management on collaborative design business models are planned based on these industrial features.

2. LITERATURE REVIEW

2.1 Collaborative Design

Collaborative design originated from collaborative commerce. It integrates the various enterprises in the supply chain through information access, and sharing to hasten company operations and derive at mutually benefiting outcomes such as Early Involvement, Design-in, and Spec-in [5] Collaborative design refers to a process in which a product design is completed under joint efforts of a company's internal and external designers. This process covers different departments and areas, i.e. design, manufacture, fabrication, and test etc. Vendors and customers may also be included in the coverage [16].

Bai et al. [1] pointed out that collaborative design plays the role of user contact, and message exchange. A user is able to connect with the internal work environment and external commercial messages bridged by operation panels, search window designs and classified message display modes. Messages in and outside the company are collected and compiled

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on a single user interface, which are subsequently distributed to other parts of the company.

To the textile industry, early involvement in design proves to be important in facilitating and confirming mutual needs and sample fabric provision. Clients will waste precious time and money if they have to search vendors again, at the same time, time to market opportunities will be lost as well. Thus, client purchase order loss will be avoided.

2.2 Design Chain

Tiwgg [13] believed that design chain manages the participant roles in the product design process. It is a comprehensive process that requires the integration of knowledge and professional capabilities from manufacture to sales. Therefore, design chain may be regarded as a special form of supply chain involved in organizational product design and RD information conveyance. To ensure time to market, product manufacture, sales quality and cost cut down, focus should be placed on the product RD process during the early period. Each bonding inside the company can be regarded as part of the design chain [9].

The role of the design chain may be oriented and further discussed from its relative positions to the supply chain. The design chain is part of the supply chain project. Its functions emphasize on design [10]. The design chain established in the collaborative supply chains among organizational systems has individual product design processes predominated by different organizations. It is like a leash that strides across organizational management and provides the final product design for the supply chain, thus, it is connected to the supply chain. Design Chain Associates [18] pointed out that Design Chain can support product design and RD, including information, tool, and method. New product design and presentation at the right time and in the right form are anticipated. From this we know that the design chain is oriented as the collaborative research relationships between up-stream and down-stream vendors or among inter-domains. Through IT and network system, the ideas of collaborative design will be implemented and collaborative operations of the engineering and technical adjustment will be arranged from the product design concept to the supply chain.

2.3 Design Chain Operation Reference Model

Supply Chain Council (SCC) is an independent and non-profit global organization. It is made up of 800 companies or organization members that highly focus on the supply chain management system and implement cross-industries Supply Chain Operation Reference model (SCOR) development. SCC proposed design chain operation model (DCOR model) based on business process management (BPM)

of HP. The process model is the main communication tool for knowledge exchange among design chain enterprises [12].

DCOR classified the design chain into 3 types namely: Planning processes, Execution processes, and Enabling processes. [12] Standard design processes are described by systematized hierarchy. Process, metrics and best practice are tools used to establish the design chain framework. [1] Similar to SCOR, DCOR is mainly used to describe, analyze, and plan the design chain by up-down analytic method of 5 major design processes (Plan, Research, Design, Integration, and Amend). Hierarchical Analysis is conducted to define the relationship between each management process. Performance index are provided as user reference when measuring the terms and conditions of process performance. [2] Nevertheless, version 1.0 is used in DCOR setup; no actual disparities have been clearly pointed out in terms of process element. As a result, metrics and best practice have not been able to be utilized in actual industrial operations. There are still inadequacies yet to overcome.

Currently, DCOR model established is still predominated by HP. They set up Business strategies, processes, information system, application services, and basic services by e-Business planning. Company strategies are transformed into metrics, spread in respective departments, linked to actual operations. Feasible processes are also measured. This step is then transformed into a Business Process to derive a common standard process, which in turn incorporates with the best example in the industry to form Best Practice. It is then utilized during information construction. An optimized new business model is established using this method.

The DCOR steps are similar to HP e-business and SCOR. Table 1 shows that scholars hold different views on the analysis and planning procedures. Since the present DCOR developments are still at the early stage, there is no comprehensive planning procedure at this point. The framework of this study is based on HP product design process reconstruction, SCOR and e-business planning method. DCOR procedure includes 5 stages: 1. Constructing As-Is design chain; 2. Enterprise strategic planning; 3. Constructing To-Be model of design chain; 4. Constructing To-Be process of design chain; and 5. To-Be Information system platform analysis.

During the analytic stage of the As-Is design chain, Stadtler et al. [11] and Tsai [15] adopted SCOR level 1 and level 2 in describing the As-Is supply chain. This study concludes that the As-Is design chain are mainly for the administrators' reference to operation strategy. Thus, the descriptions should merely be stated in the business model.

During the business strategic planning stage, SCC [9] analysis on industrial environment

competitive strategy is rather insufficient. Kluyver [8] proposed planning processes related to e-business and believed that a company must first understand its advantage in e-business and position in the industrial environment. Fingar and Aronica [4] also expressed that e-business strategies and process executions should include result feedbacks and corrective functions. The 4 processes proposed include: (1) customer value analysis, (2) Business Strategy formation, (3) value chain reorganization, and (4) implementation.

During the To-Be design chain model analysis stage, Huang et al. [7] pondered upon the To-Be model based on the As-Is model. This thinking process requires strategic creativity. Strategies open up doors to performance index selection, measurement and To-Be model upgrade. Although Stadler et al. [11] and SCC [9] used performance index to measure the inappropriate parts of company operation performance, the search of root problems and the To-Be business model formation process are seldom mentioned. This study has adopted the Cause-and-Effect diagram, ex. fish bone, strategy map, and balance scorecard in the search for root problems. Other improvement methods on design chain management are also referred to, ex.

collaborative design. Hopefully, the design chain improvement process will become more transparent and structuralized.

During the analytic process of To-Be design chain, Huang et al. [7] the process model is determined by the To-Be business model. HP measures feasible business processes using metrics.

During the analytic process of To-Be information system framework, business process and industrial Best Practice are combined to form the solution plan used in the information system Framework. DCOR of SCC [9] provides the performance index of each process as reference, but without solution plans and feasible information system features. This study serves to Chen reference [2] in collaborative design which is regarded as a strategic method used to integrate design chain members. By means of collaborative design, the core factories in the design chain may cooperate more closely, which in turn promotes the establishment of simulated professional RD design chain integration.

Using DCOR as an analytic tool in this study, technical textile industry related design processes are discussed; meanwhile, case studies on collaborative design will be discussed on a deeper level.

Table 1: Literature review of process analysis and planning by scholars

DCOR Planning Process Analysis					
HP	1. Business strategy	2. Business process	3. Information system setup	4. Application Services	5. Basic services
Chen et al. [2]	1. Design chain business model	2. Design chain collaboration	3. Design chain process model	4. Design chain business model	
E-Business Process Analysis and Planning					
Huang et al. [7]	1. Business model	2. Process model	3. Information technical model		
Snell and Bateman [10]	1. Strategic planning	2. Tactical planning	3. Operation planning		
SCOR Process Analysis and Planning					
SCC [9]	1. Competitive strategy analysis	2. Supply chain construction	3. Use of performance index, solution plan and software system	4. Induced supply chain process and system	
Stadler et al. [11]	1. Competitive strategy analysis	2. Supply chain construction	3. Use of performance index, solution plan and software system	4. Induced supply chain process and system	
Tsai [15]	1. Supply chain analysis	2. Supply chain performance analysis	3. Supply chain business model design		
Chen and Lin [3]	1. Existing supply chain condition	2. Business Strategy analysis	3. Supply chain improvement plan	4. To-Be information system framework analysis	

3. DCOR ANALYSIS AND PLANNING PROCESS

DCOR a reference model planned and improved to totally reform organizations and processes in the pursuit for dramatic performance growth, is an up-down analysis on the As-Is design chain. The DCOR planning procedures proposed in this study

first undergoes As-Is design chain analysis, and up-down strategic hierarchy analysis, which serve as guideline in the overall improvement planning. Eventually, a business model is planned, followed by detailed operation procedure related planning. Finally, information system setup is supplemented. For details, see Table 2.

Table 2: Design chain DCOR planning procedures

Design Chain Planning Procedures	Content
1. Constructing design chain As-Is	(1) Present industrial analysis and company background (2) As-Is business model description and analysis
2. Enterprise strategic planning	(1) Competitive environment analysis (5 forces analysis) (2) Strength and weakness analysis (SWOT analysis) (3) Business strategy roadmap
3. Constructing model of design chain To-Be	(1) KPI selection and measurement (2) To-Be business model description and analysis
4. Constructing process of design chain To-Be	(1) To-Be process model analysis
5. Information system platform analysis To-Be	(1) Information system planning (2) To-Be design process descriptions (3) Use operation procedure solution plan

3.1 Constructing Design Chain As-Is

DCOR planning should begin with understanding industrial environment and company operation background to construct the design chain As-Is in this study. The procedures are listed as follows.

3.1.1 Industry Analysis and Company Background

Prior to DCOR analysis conduction, management is recommended to first attain sufficient knowledge on the company such as industrial environment, and business scope etc. Company background analysis is helpful for later company environment analysis, strategic goal analysis, and performance index setup.

3.1.2 Business Model Explain and Analysis As-Is

Prior to design chain analysis conduction, company business model design processes must first be described. Design activities should be differentiated from client, company and vendors. Preliminary analysis may be done on the interactive processes, design planning items and scope in order to understand the activities covered in the design processes.

3.2 Enterprise Strategic Planning

To understand the present competitive environment of a company, the Strength and weakness are classified to find the potential business opportunities. Many tools may be used in strategic analysis such as Benchmark, SWOT, and Five forces. The analysis tools assist in the planning of Business strategy blueprint, and shift of time and strategy.

3.3 Design Chain To-Be Model

With Business Strategy analysis as the main axis in conjunction with the measurement results of Strategic performance Indexes, the obstacles and crucial issues in the way of present company operation are found out. After ascertaining on the

focus and basis of the design chain improvement plan, DCOR processes are used as reference in inducing the To-Be design chain business model diagram.

3.3.1 Select and Measure Strategic Performance Index

The main focus during Strategic Performance Index setup lies in the fact that indexes must combine with business strategies to effectively serve as reference for the management. Through DCOR provided metrics, strategic performance indicator planning is done. Lastly, through discussions held, other design chain improvement methods (ex. collaborative design) serve as reference when setting up a new design chain improvement plan in solving problems.

3.3.2 Explanation on Business Model and To-Be Analysis

Construct a company To-Be business model in conjunction with Strategic Performance Index Measurement and design chain improvement plan. Company strategic selections are determined to indicate the shift direction from As-Is to To-Be.

3.4 The Process of Design Chain To-Be

The process model determines how the To-Be business model should operate and how it shifts from As-Is operation to To-Be operation. Therefore, the design of the process model depends on the To-Be business model. DCOR level 1 and level 2 Diagram is adopted in this study to describe the To-Be company design chain process model.

3.5 To-Be Information Platform Analysis

3.5.1 Information Platform Planning

During company process reform, the aid of the information system deems necessary to simplify operation procedures, enhance operation efficiencies, lower business costs, and shorten operation time. Using improved design chain processes as the main

axis in this study, and design chain IT solution plans, a new company information system framework is planned. Competitive advantageousness is created with the help of information technology.

3.5.2 To-Be Design Operation Procedure Descriptions

Based on level 2 process in the last stage, Level 3 is initiated. More detailed descriptions will be stated.

3.5.3 Use of Operation Procedure Solution Plan

Based on each operation procedure, design chain related solution plans will be provided. When problems occur in a process, they may serve as reference for the management.

4. CASE STUDY

4.1 Constructing Design Chain As-Is

4.1.1 Industry Analysis and Company Background

In the textile industry, if commercial model and added value were to be differentiated, a hierarchy pyramid arranged from regular fabric producers to high-rank technical fabric producers would derive. (as shown in Figure 1) the operation items include: 1 time process (plain weave, knitting), and 2 time process (plain weave, Coating, knitting stick on), more than 3 times process (functional stick on). The added values for respective operation items also vary. Based on this, it is necessary for the textile industry in Taiwan to strengthen its competitiveness, and avoid being in the chaos of price cut-downs. The collaborative commercial models of ODM and OBM and the value added technical fabric market will turn the table around. So, the only ways to prosperous company developments are through company design RD capability upgrade, front-end, brand collaborative design back-end and vendor collaborative research and integration as the company heads toward the 2 ends of the smile curve.

The business items of S Company are mainly technical fabric, plain weave knitting, multi process and import and export sales round the world. The main client sources are well-known sports gear brands such as NIKE, ADIDAS and REBOK etc. Various types of technical fabric, sportswear, leisure clothing, and technical attire are provided by S company,. It also work closely with clients, and textile centers while actively being involved in professional RD technical products in order to provide clients with more versatile and value added

products and services. Companies also attend international exhibitions annually to provide the latest products for long-term brand dealers. At same time, brand dealers are also invited for company visitations where new market trends and new product development plans may be discussed. The prospect of the company lies in the hope that it will become the leading technical textile products in the world and that self-made fabric brand value can be increased.



Figure 1: S company position in the local and overseas textile industry

4.1.2 Explanation on Business Model and As-Is Analysis

The As-Is design RD process is based on client provided product concept needs and the technical fabric type is developed by S company. Each year, S Company visits the brand dealer head quarter to attend new product RD meetings and provide fabric type and design concepts to brand dealers. It also acquires a lot more analysis and concepts related to new vogue trends. brand dealer sends completed design RD sample to S Company and discusses technical fabric requirements accordingly. After S Company issues fabric specifications, it requests cotton, weave, dye factories to start production. level 1 factory then undergoes technical fabric required technical developments. Finally, completed technical fabrics are then sent to designated apparel factory to begin production. S Company should communicate with vendors regarding RD design, fabric specification verification, process processing, sample test, sample dye before discussing with client. If results are unsatisfactory, repeat. This process requires 3-5 trials, and each trial lasts for 30 days. A product development cycle usually takes 120 days, which takes up more than half of the time from RD design to delivery.

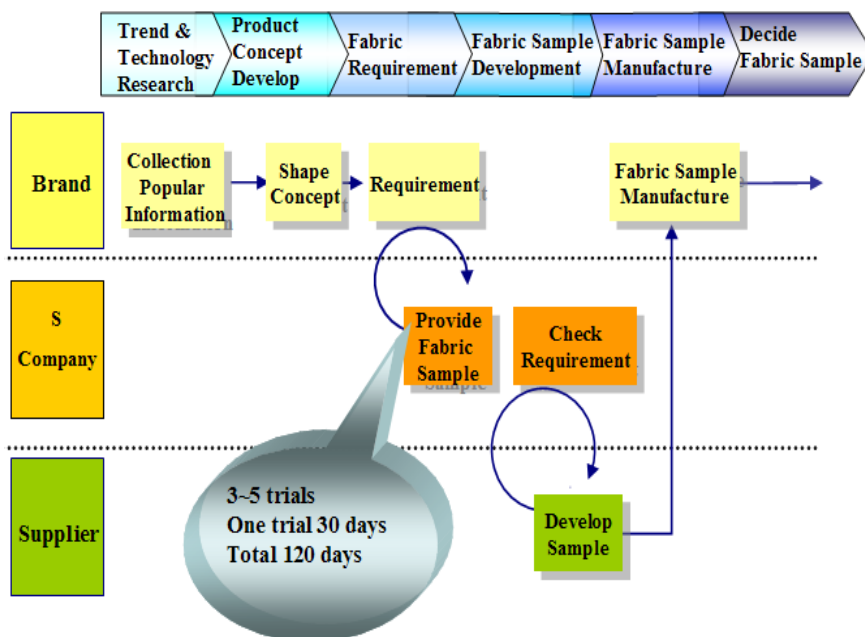


Figure 2: S company As-Is business model

4.2 Enterprise Strategic Planning

4.2.1 Competitive Environment Analysis

Respective force analysis conduction in the industry are as shown in Figure 2. In the face of To-Be under the overall supply chain competitive environment of the technical fabric industry, collaboration and more intensive process integration will be the key to the next opportunity for growth. Thus, the concrete strategic goal is to become a significant partner of the brand dealer during prompt release of new products. Hopefully, the dominating role and competitiveness in the value chain system can be strengthened.

4.2.2 Strength, Weakness, Opportunity, and Threat Analysis (SWOT Analysis)

Through SWOT analysis dimensions, S Company is observed in the search for suitable strategic actions. (As shown in Table 3)

4.2.3 Business Strategy Blueprint

Since organization resources are limited and respective action strategies are interrelated, action strategies may be positioned based on their respective schedules. (As shown in Figure 4) The different time frames of each action strategy have their own values on company growth when the main action strategies are initiated.

4.3 Explanation on Business Model and To-Be Analysis

Using the 3 items in the business strategic planning, strategy map concepts are introduced to instantiate respective actions. Refer to DCOR metrics for detailed performance indexes of respective processes. The improved To-Be model of the design chain is also induced.

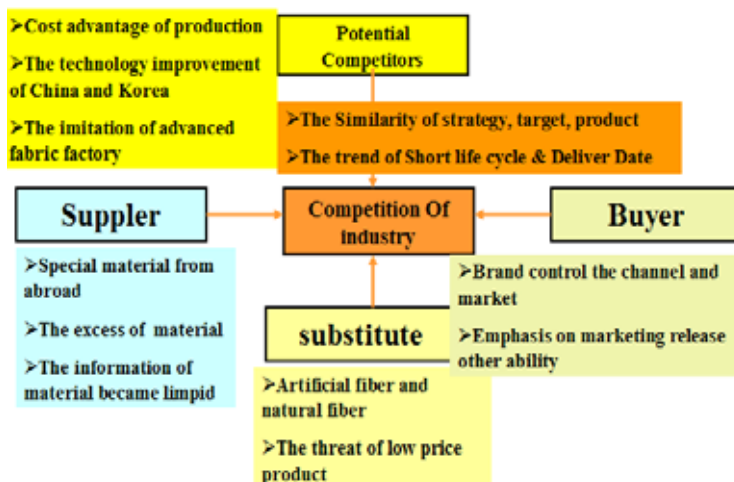


Figure 3: S company 5 force analysis

Table 3: SWOT analysis and strategic planning

	Internal Strength (S)	Internal Weakness (W)
	1. Technical and product development capabilities 2. Self-made fabric brand 3. Possess collaborative design capabilities	1. Contact with terminal-end consumer market 2. Few intellectual property patents
External Opportunity (O) 1. Emergence of new market 2. Channels focus on branded business operation	SO strategy (strength expansion development) ➤ Strengthened collaboration capabilities ➤ Overall solution plans provided for clients	WO strategy (opportunity overcomes weakness) ➤ Participation in the two ends of the extended value chain
External Threat (T) 1. Rise of low cost competitor 2. Advanced fabric merchants' imitation capabilities 3. Brand dealer oriented market	ST strategy (strength overcomes threat) ➤ Industrial performance and economic development and collaborative development integration	WT strategy (improves weakness; reduce threat) ➤ Strengthened patent acquisition and application

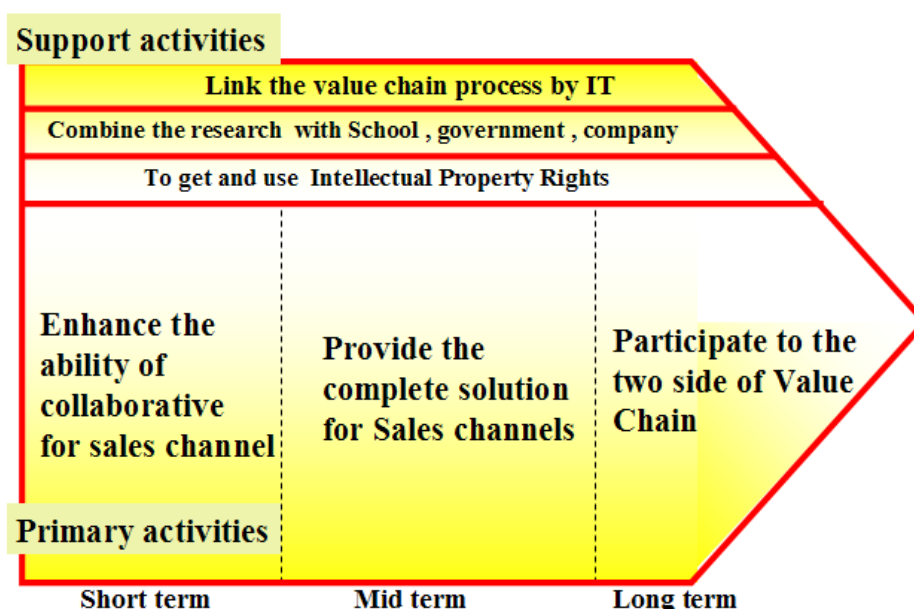


Figure 4: Strategic schedule shift and positioning

4.3.1 Select and Measure Strategic Performance Index

The focus of strategic performance index setup lies in the integration of the indexes and the business strategies. They should be consistent and suitable for each other. The main action strategies of S Company are: “strengthened collaboration compatibilities”, “overall solution plans provided for clients”, and “involvement in the two ends of the extended value chain.” With company value growth as the ultimate goal, strategic map concepts are introduced to initiate the 5 actions. (As shown in Figure 5) Thereafter, performance assessment indexes used in developing

actions are used to assist S Company to examine performance. Related improvement measures are conducted to maintain long-term overall competitive advantageousness and benefits. The concepts of the “balanced scorecard” have been adopted in this study. DCOR provided performance indexes also serve as reference in setting the indexes of the To-Be process.

The aforementioned critical factors are considered in this stage. Collaborative design concepts are introduced together with IT platform use in the solution plan aim to minimize unnecessary processes, strengthen process integration and achieve action goals.

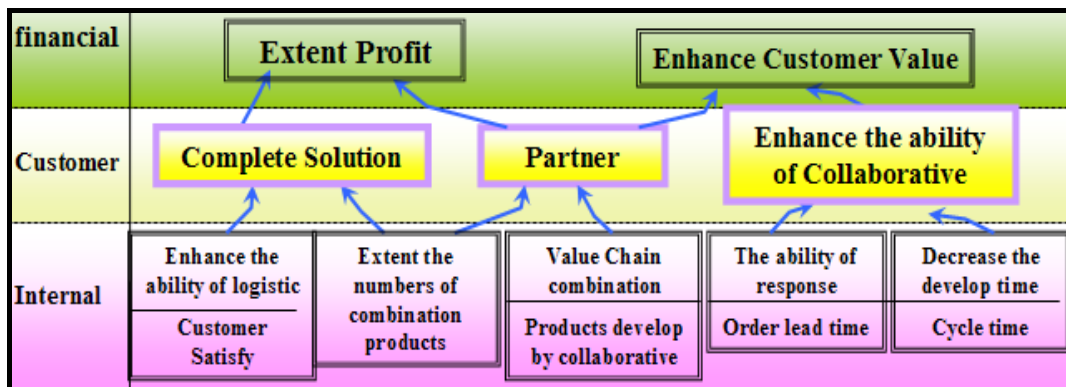


Figure 5: Company strategy map

Table 4: Strategic performance index

Business Strategy	Action	Strategic Performance Index
Strengthened collaborative capabilities	Reduced development cycle time	<ul style="list-style-type: none"> ■ Product design cycle time ■ Times of design changes
	Strengthened response capabilities	<ul style="list-style-type: none"> ■ Amended cycle time ■ Product design change cycle time
Overall solution plan	Strengthened logistics collaboration	<ul style="list-style-type: none"> ■ Mass production time ■ Time of new product release
Two ends of the extended value chain	Critical technique development and control	<ul style="list-style-type: none"> ■ Numbers of creative development case proposals ■ Numbers of collaborative development projects ■ Patents per product ■ Design chain FTE per product design
	Strengthened brand value	<ul style="list-style-type: none"> ■ OBM product ratio ■ First to deliver new idea to market

4.3.2 Explanation on To-Be Business Model and Analysis

The above strategic performance indexes have adopted collaborative design Innovation and Early involvement concepts, and IT platform setup in order to improve the business model.

Collaborative platforms allow brand dealers, S Company and vendors to participate in the various stages in advance so that time spent on transmission and alterations (back and forth) may be reduced. Meanwhile, related support systems also facilitate rapid response to brand dealers problems and thoughts so that Numbers of alterations on design completed products can be decreased. It will in turn hasten developments and aid brand dealers, S Company, and vendors during product alteration.

Discussions will be held on the alteration process to rapidly derive at critical points, announce alteration plans and promptly answer client needs.

Using the collaborative design platform, information exchange and communication maybe shared. Information and requirements are then grasped in order for collaborative factories to promptly provide support and make adjustments so that the overall value chain efficiency may be enhanced.

Development staff may use the platform information function to avoid making wild guesses and speed up the development schedule. Also, the collaborative platform may provide support on the collaborative part with external RD institutes. External forces may be utilized in boosting RD.

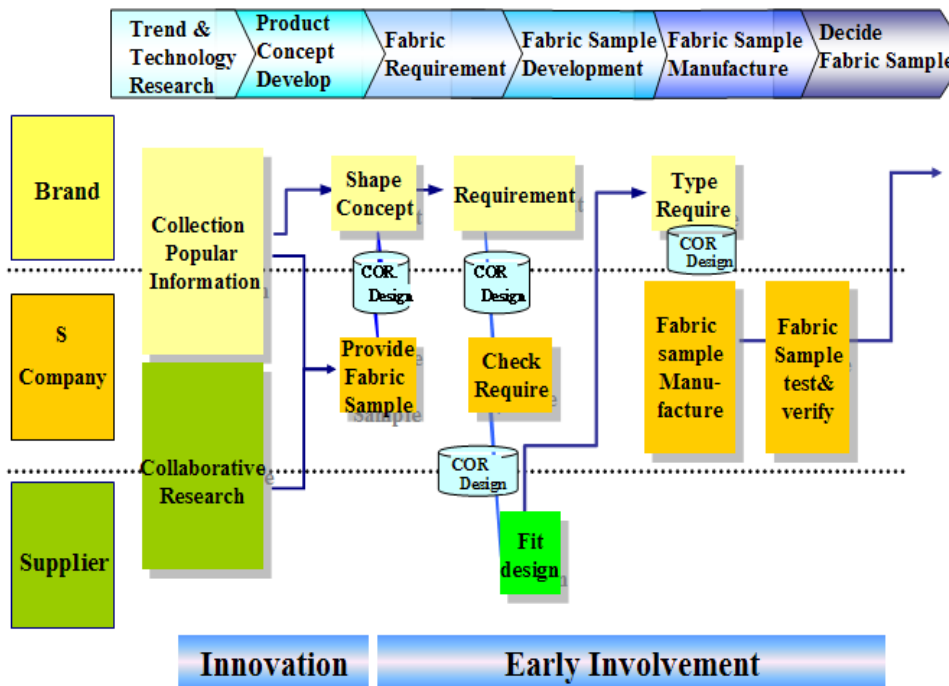


Figure 6: S company To-Be business model

4.4 The To-Be Process of Design Chain

In conjunction with new business model and design chain improvement plan, DCOR level 1 and level 2 process element diagrams are used to describe the To-Be process model. Focus is placed on metrics improvement, based on DCOR standard process with suitable IT, to reduce labor, and time needed for manned operations. The S company will be able to participate in brand dealers’ collaborative design in advance and accomplish the benefits of innovation, and early involvement.

4.4.1 Role Presentation of Level 1 Design Chain

Using DCOR standard process with the IT collaborative design platform, all standard operation procedures undergo online information exchange in order to improve communication efficiency. S Company will promptly respond to client needs, and reduce the Times of design changes, and then find the suitable Supplier immediately to participate in and research, to reduce the development cycle time of the overall product development. The 3 main guidelines are:(1) coordination respective plans (2) S Company early participation in collaborative design (3) Supplier early involvement in collaborative research (As shown in Figure 7).

4.4.2 Level 2 Design Chain Process Interpretation

Brand: Through the collaborative design platform, Brand and supplier have the same reference of fabric sample, They can discuss about the fabric development with S company and suppliers immediately, The times of sampling will be reduced, **S Company:** S Company can collect client needs

online immediately, and then provide sample fabric data, and other functions such as simulation system. The interaction efficiency with clients will be enhanced, the time requirement on client need confirmation and RD sampling will be reduced during the Design Phase.

Supplier: When developing fabrics, the S company will check whether there are RD solutions to such technical fabric from the database, if it’s critical techniques, the S company will develop it by self, if not the RD will handle by suppliers deepening on actual scenarios. Through collaborative research mechanisms, the RD processes of both parties are highly integrated to hasten fabric developments. (As shown in Figure 8)

4.5 To-Be Information Platform Analysis

4.5.1 Information Platform Planning

To summarize enable definitions and the metrics of DCOR, we can establish Figure 9, which show the various definition and feasibility information system solutions, and then build the information system module to support collaborative design. Based on table 5, the content details of each module, Enable support and sub-models etc. will be attained.

4.5.2 Description on To-Be Design Process

After module Definitions, first analyze the Level 3 To-Be framework, to understand the key point of each process and the solutions to reduce cycle time, think about the modules and suitable functions, finally go by DCOR five operation processes and the information flow, we can construct the complete To-Be design process. (As shown in Figure 11)

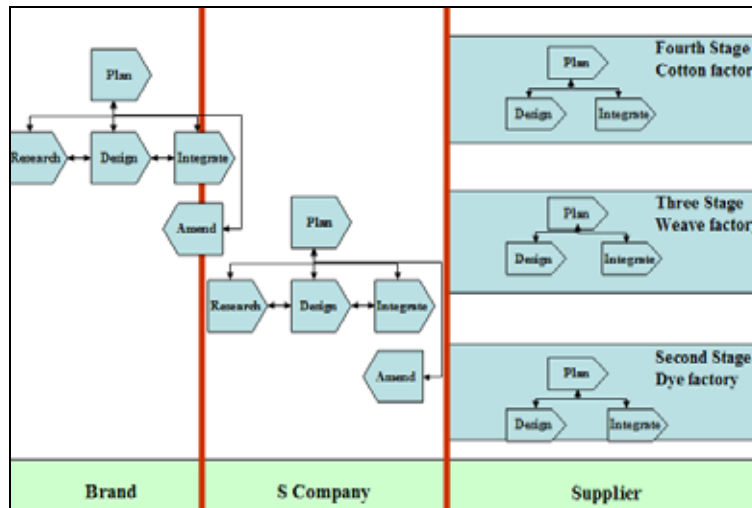


Figure 7: S company DCOR level 1 To-Be design chain member analysis

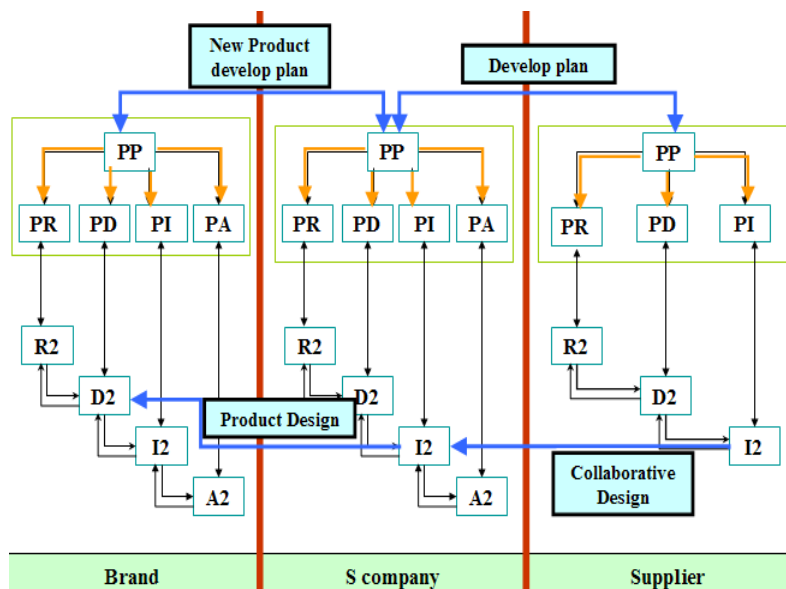


Figure 8: S company DCOR level 2 To-Be design chain member analysis

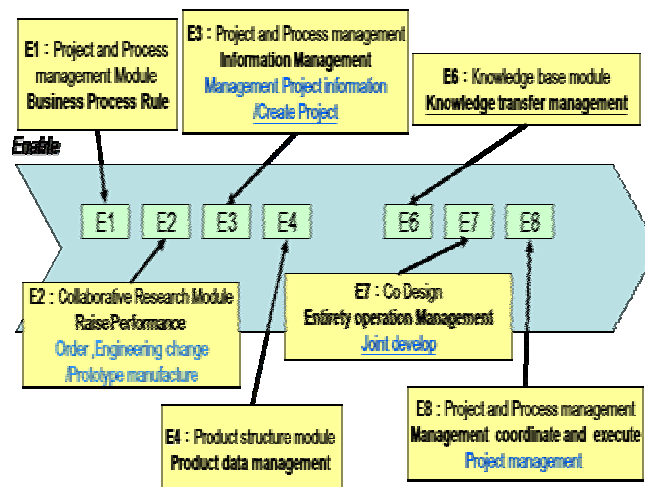


Figure 9: Enable definition and module support

Table 5: Module definition

Module	Description	DCOR Enable Function	Sub Model
Co design	A platform provided for clients and vendors in conducting creative concept, design specification, textile external appearance and quality related discussions.	E7: Entirely operation management	Collaborative design discussion area, Multi-layer process design area, Fabric, Specification, External appearance simulation
Project process management	Integrated management on project information.; wizard is used in project setup, alteration and inquiry.	E1: Business Process Rules E3: Information management E8: Management coordination and execution	Project management model, Process management model
Knowledge base	Provide As-Is fabric data presented by simulated method.	E6: Knowledge transfer management	Simulated system, Fabric database
Product structural	Centralized control on all enterprise product data.	E4: Product data management	Product classification model, Product model/type management
Collaborative research	Collaborative design project given to vendors, clients and core factories.	E2: Raise performance	Purchase order management, Engineering change, Sample trial production

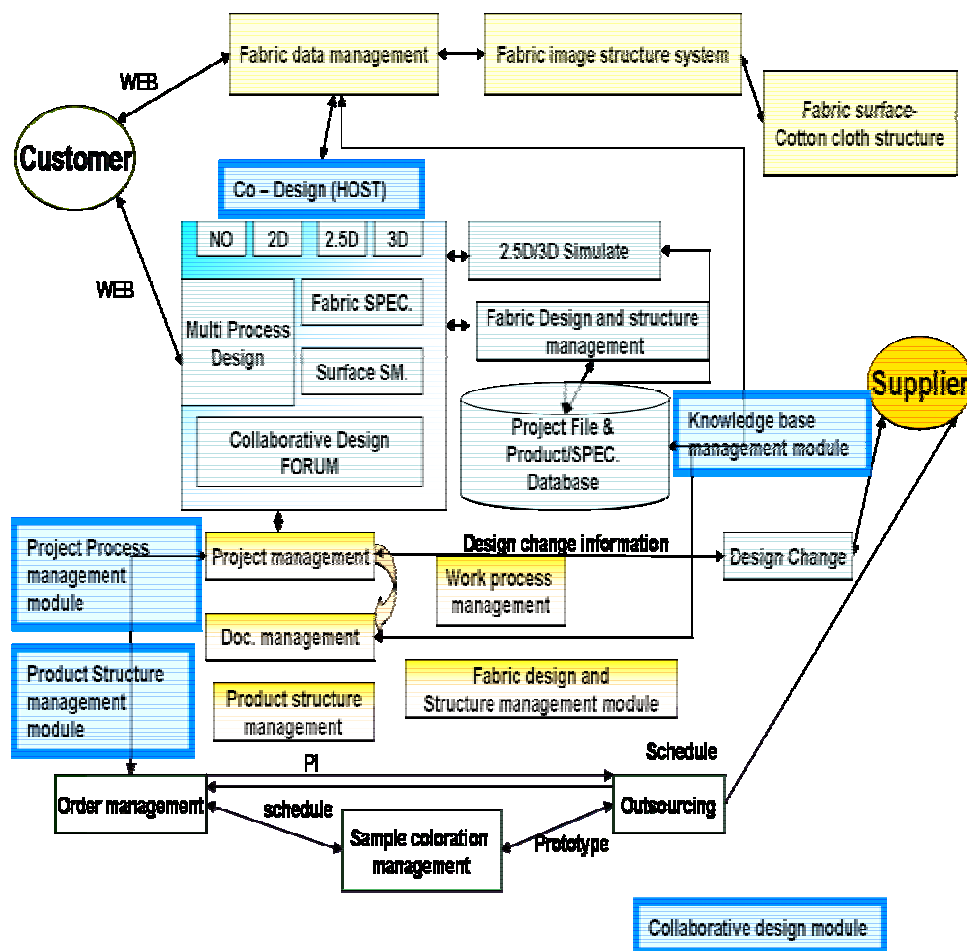


Figure 10: Model operation diagram

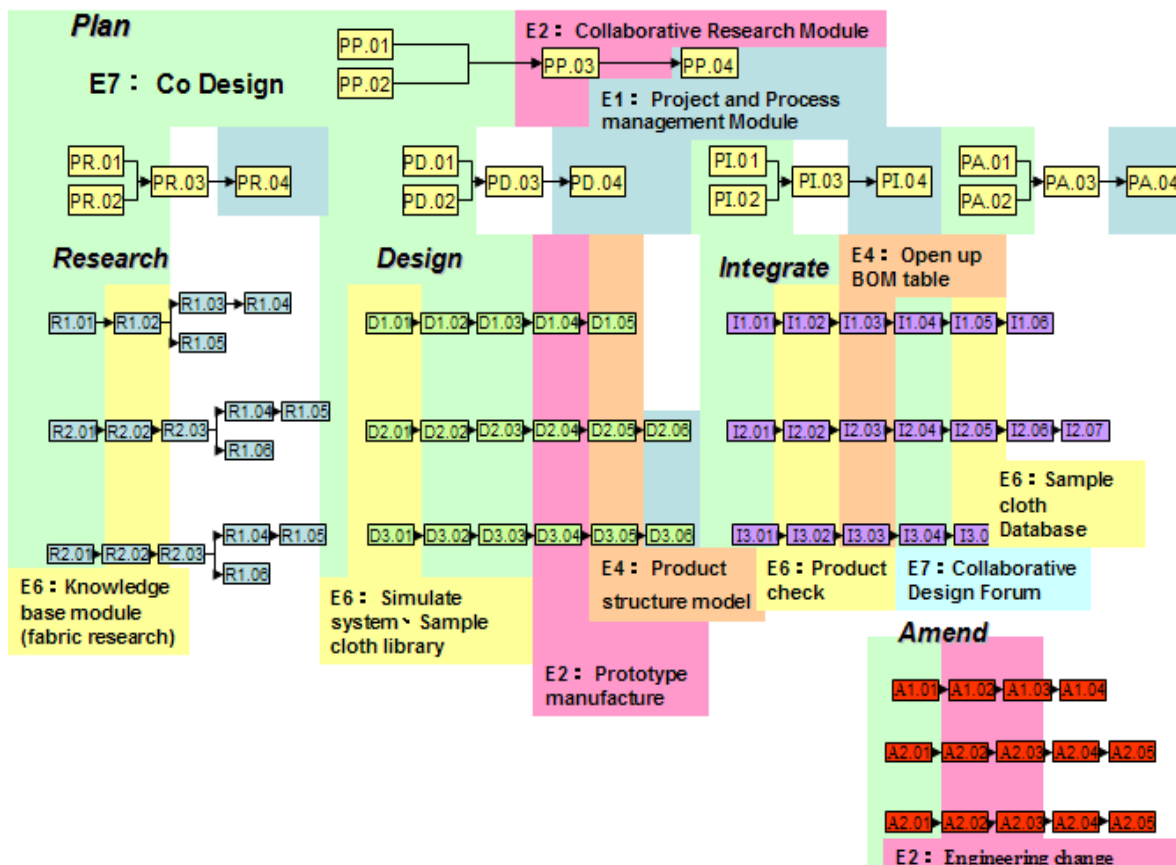


Figure 11: To-Be design chain process analysis

4.5.3 In-Use Operation Procedure Solution Plan

- A. First (E7) Co-design module support the process (PP) collected clients’ needs, the module also provides fabric specifications and external appearance simulation for clients’ preferred selection online, and then the suppliers can understand new fabric developments at the collaborative design forum, also the (E6) knowledge base can provide developed products information to suppliers. To continue, the module (E2) collaborative research module with it’s sub module purchase order management handled clients’ orders, finally in the process (PP04) a set of design chain plan defined by the (E4) project process management module.
- B. After design chain plan accomplished, through (E3) project and process management module integrated, summarized client requirements then analyzed product design requirements and technical RD, in terms of technical RD, (E6) knowledge base will show that if fabric RD techniques on hand are available to engage in new fabric developments.(R2) Evaluate critical techniques or whether outsourcing developments are suitable, collaborative RD is discussed with clients and suppliers at collaborative design forum (E7).
- C. In terms of the design aspect,(E6) knowledge

- base module provided data for sample fabric simulation and sample fabric data serves as reference during 3-party discussions. After discussion results are obtained, sample fabric development is done by (E2) collaborative research module then, (E4) product structural module provided product structure setup, alteration, deletion, and duplication, and both product concept design and mass production stage are under the supervision of this module. Finally, a complete set of design documents is setup by the (E3) project process module purchase and production are conducted during official operation after being transferred to production management system.
- D. In terms of integration, after demands have been integrated (I2.01), knowledge base model (E6) confirmed the sample fabric after discussions conducted by design, and research process. By means of the product structural module, (E4) the integrated BOM table is handed to suppliers. Suppliers may make use of the collaborative design discussion forum in holding discussions with S company, and clients on issues related to fabric developments and problems. The sample fabric database may also enhance the creativeness for designers.
- E. In terms of Amend, (E7) Co-design module

allows one to understand client problems timely, technical fabric engineer specification alterations are done by (E2) collaborative research module until customer satisfaction has been reached.

- F. In view of the above module support, they are intended for staff operation error reduction for the efficiency, and decrease times of process cycle time design changes, early involvement in the client and supplier collaborative design. Information follow among the 3 parties will be prompt, transport, product development will be smooth, and works will be completed ahead of schedule. Eventually, products will be released in the market early, which facilitates purchase order acquisition, and the goals of collaborative design will be achieved.

5. CONCLUSION

After Taiwan entered the WTO and due to the cancellation of the quota system, the textile industry is now in the face of structural transformation and technical promotion. Competitions from low-cost labor Southeast Asia and Mainland China caused the industrial value and production volume of the apparel and clothing sectors to reduce year by year. However, high-price finished fabrics and mechanical fabric production volume increase each year. At present, middle-low level textile companies head toward the trend of global logistics planning while high level value added technical textile enterprises are now developing a collaborative production system that has international purchase order fulfillment and creative RD capabilities.

Nevertheless, there is no fixed design chain construction or operation method in the technical textile industry. This result is in operation system inefficiency and delay (manned operation) among systems. Therefore, we have adopted DCOR in establishing an optimized operation model in the sector. It effectively coordinates collaborative design processes among systems; minimize planning, RD, design, integration, and cycle time needed for improvement. Consequently, the times of design changes is further reduced. The core factories and vendors are able to determine their self-developed core capabilities and critical processes in advance. They may even decide to engage in outsourcing so that the collaborative design may be simplified. Early involvement in the textile industry ensures Design in, Spec in., and products may be released in the market earlier with grater profit gains. It further assists enterprises to acquire the integrated "optimized global design chain."

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