Analysis Guidelines for Customised Orders in an Apparel Chain

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Abstract

Over the last decade, several papers have been published on the strategy of mass customization, but most of them hardly provided practical solutions. This research aims to analyse customised orders for the taking of parts in apparel production systems against lead-time performance. A leading-edge company of the Thai apparel industry is selected to apply the concept of customized producers. Attempting to develop this issue, the study first synthesizes the mass-customised apparel principle. Secondly, it examines as-is the supply chain to investigate problems and the efficiency of core business processes after customers place customised orders. Thirdly, to respond to product variety for competition, it proposes some apparel supply chains or apparel chain strategies under the definition of Mass Customisation (MC). Finally, this paper proposes the directions to analyse the effects of customized orders in apparel production systems using simulation modelling.

Keywords: Mass Customisation, Customised orders, Supply Chain, Apparel, Simulation

1. Introduction

The textile and clothing industries have been major businesses in almost every country and have been placed as one of five fundamental industries in addition to food, automobile, information and communication technology, and tourism by Porter [1]. Especially after the free trade agreement in 2005 and the Bangkok fashion industry, there is more and more severe competition. They represent one of the largest sectors in the Thai economy in terms of Gross Domestic Product. In addition, the National Economic and Social Development Board (NESDB) of Thailand is in agreement with entering the strategy of Mass Customisation.

In this paper, various research methodologies are classified into the qualitative approach (empirical research) and the quantitative approach to solve the problem when an apparel company wants to change mass production policy to mass-customised order production policy, producing one piece to optimal pieces on order. The study is conducted through both empirical research based on interviews with apparel companies in Thailand using Business Process Analysis in the following section of empirical findings and supply chain management and simulation modelling limited by the production process for a shirt company in Thailand. It has a vision and a potential to become an MC producer, which is the reason why this company is selected to study. Supply chain management solves the problem of apparel chain and simulation modelling deals with the comparative method of Mass-Produced Apparel Production Systems (MPAPS) and Mass-Customised Apparel Production Systems (MCAPS) after obviously understanding the attributes of production line types.

2. Mass Customisation in apparel

The literature survey in this research focuses on Mass Customisation. The objective of the literature survey on mass customisation is to provide a source of knowledge on the subject in which further investigation can be performed such as Sirovetnukul et al. [2]. The literature survey investigates the current understanding of

Mass Customisation across a wide range of literature from the first International Conference on Mass Customisation and Personalisation (2001). Six sets of literature have been identified, which reflect or relate to existing understanding of mass customisation: Business Strategy of Mass Customisation and Personalisation; Mass customisation and Personalisation in E-Business; Product Design for Mass Customisation; Manufacturing for Mass Customisation; Consumer Behaviour Issues; and Information Systems for Mass Customisation and Personalisation. Today enterprises need a manufacturing system that can adapt quickly to changing market conditions, provide the lowest costs, process correctly the first time and give customers what they want, when they want it. Mass Customisation can do exactly that. Mass Customisation focuses on the entire enterprise from the order fulfillment, through flexible manufacturing, to efficient distribution systems. Some experts in MC such as Brabazon and MacCarthy [3] advocate that MC operational strategies have not yet found and research is still necessary. Silveira et al. [4] merge some MC concepts and propose eight generic levels of MC, ranging from pure customisation (individually designed products) to pure standardisation: design, fabrication, assembly, package, distribution, additional custom work, additional services, and usage. In addition, the authors synthesize and expand their generic MC levels by adding the research of some papers such as Spring and Dalrymple [5]. In manufacturing, its progress has been divided into broad and specific aspects of mass customisation such as product design and configuration; as well as process planning and scheduling, but there are few published reports directly addressing the problem of practising mass customisation [6]. However, several companies of some industries such as Computers and Bicycles have proved that MC can be a reality, not just a pipedream. There is still much debate on how to design effective MC systems [7]. From our preliminary study, the most important reason why it is hard to create a generic MC model to response to many industries is because MC is only terminology, and every solution is essential to define the obviously in-depth problem. MC is nowadays driven as a focal strategy by the NESDB of Thailand. As a result, to fulfill the prior gaps, this research studies and deals with the problems of customised orders in Thai apparel chains.

2.1. Customised order for apparel

Although clothes are a basic need of the customers providing comfort and hygiene, they also depend greatly upon customers' personalities and preferences. The general premise comes from the fact that customers expect different value from various clothes. Therefore the manufacturer has to provide clothes with obvious attributes or features in order to respond to the customers' value. There are many factors that a customer can choose for clothes. These features are body size (grade size or customised size); gender (ladies' wear, men's wear or children's wear); age; design, style or model (formal wear, casual wear or sportswear); material; colour or pattern (monogram and logo); accessory (embroidery, printing, etc.); and finishing. Each clothing company must be aware of selecting these features as its unique characteristics. Clothes can be considered as basic products or fashion products. The basic products have distinct cycles in their selling over the years, which follow seasonal changes. For fashion products, the rate of change in customer needs and demands are very high in this industry. Products tend not to be repeatable and customers tend not to have repeatable demand. What is fashionable today may not stay in the market for more than 6 months. However, this research gives an interesting view on how variety under basic and fashion products has developed in the garment sector. According to a study Kurt Salmon Associates [8] conducted for $[TC]^2$, a leader in research and development and education for the sewn products industry, Mass Customisation can be positioned into three categories. Each of them responds to individual customers' desire. These three levels are:

- Personalisation: The customer orders mass-produced products, which are then personalised according to their request. For example, a consumer can order a tennis shirt with his/her initials in a specified colour.
- Fit: Customer's measurements are incorporated into the initial garment manufacturing process, and the items are manufactured individually to satisfy those

specifications. The client may later come back for a fitting and more tailoring.

- Design: The customer participates, more conveniently with means of electronics, in the design and/or colouring of the individually manufactured garment that includes the elements of personalisation and fit.

The customised order may mean uncertainty in demand reciprocally, so that many characteristics of the products above make the uncertainty in demand, happen.

2.2. MC Apparel Production Process

The apparel, which is in the last part of textile production, is processed through several stages, i.e., cutting, embroidery or printing, sewing, and finishing. There have been a lot of approaches from many authors to achieve MC. As in the preceding section, three main ways are adopted in process, i.e., postponement, cut-to-fit, and design. Postponement is a powerful method that provides customisation to the customers, particularly in the level of personalisation. Two examples of companies who use the postponement approach are Benetton that emphasises colour and Kikomo that is flexible on colour and pattern. Pursuing mass customisation, the pattern is based on a standard body of the target customer. The standard size is adjusted to fit individual consumer specifications depending upon the companies that define sizes and dimensions. Therefore, standard sizes seem to be part of postponement. Design options are composed of a standard and new options that are costly. In execution, it currently provides the consumer flexibility with manufacturer and retailer's designs based on standard processes and sizing, with standard options in style, style detail, colour, and fabric. Moving at a higher level, several authors have mentioned the nuances of mass customisation practices through cut-to-fit customisation in the garment industry. Co-Design may offer the same range of choices as designed options with the addition of personal fit and support by a design manager.

MC might be an expensive proposition but to add more experience with the manufacturing technology and to develop good management, these costs will decline. Todays in mass customisation practices, the apparel industry limits the customised extent of the product market to reduce costs. The custom owner prescribes a limited number of style variations and size ranges. However, the following problems need to be resolved for the full implementation of MC toward consumers.

Under the production process there are many constraints understood and considered clearly. For instance, an informal, casual or standard shirt requires less specialised competence and high quality than fashion shirts. Subsequently, basic, casual and fashion products fill in the gap of mass-customised attributes.

2.3. Limitations for Mass-Customised Apparel

Due to a lot of definitions of MC apparel, this research determines its obvious boundary before developing into the next state. The mass-customised apparel order defines the production of specified optional products and their volumes determined by a manufacturer. They consist of additional features of more than the existing standard options, and no repeat orders. In addition to supporting the goal of the MC definition, Lin et al. [9] report that almost all of the respondents or companies tended to give high scores to all four of the dimensions or output measures (quality, cost, time and flexibility). The deviations of all dimensions are very similar. It becomes evident that all four dimensions are of general importance to mass-customised apparel. To achieve them, companies need to look into the entire supply chain. However, at the beginning stage this research only focuses on the lead time of apparel production systems.

3. Empirical Findings and Supply Chain Management

Before the research is narrowed down into the one company selected, the background and empirical findings of MC in the Thai apparel industry are surveyed and concluded. Seven Thai apparel companies surveyed are the make-to-order and make-to-forecast manufacturers. Their customers range from a well-known company such as Nike and Tommy or even independent shops (retailers). These garment companies produce various styles of men's wear, ladies' wear and children's wear from basic wear to high fashion dresses with a number of accessories. About 3-6 months before starting a new season, their customers will make an order and provide specifications in

detail. Each order is another choice from the degree of customisation. The design process is usually not conducted by these companies even though they are leading garment companies in Thailand. Few companies in Thailand make design clothes by themselves. Most companies lack their own brand names. After that, the garment manufacturers start to order a lot of materials needed for the production. At present, the forecast orders are decided by customers. The companies' chief materials are dyed fabric, which some order from owned textile companies, and accessories which may be either imported or produced by themselves. Getting more than 85 percent efficiency of fabric utilisation (with human working), these companies spend an extra two hours of labour doing it. The production processes, which include cutting, printing, embroidering, sewing, and finishing, are labour intensive. There are many inspections in each stage of production for fabric checks. Most finished garments are shipped by the due-date of approximately 90-120 days from picking up an order. Approximately sixty to ninety percent is exported to the overseas market. Communication or co-ordination between each department is not connected. In other words, the supply chain is still imperfect. For example, long lead times result from dyed fabrics and/or transferred accessories. Long waiting periods are becoming increasingly unacceptable and there is at least as much pressure to reduce lead time as to reduce costs. Most companies are also currently squeezed to be MC. However, their production needs to employ both MTO and MTS to survive in competition. Based on the business process analysis, the current situations and the supply chain improvements are studied in the following section.

3.1. Current Situation

3.1.1. Apparel Supply Chain

Supply chain management, as a new industrial-wider management strategy, has become the solution for improving competitiveness. For an overview of the textile industry, the supply chain for textiles consists of four business units, i.e., yarning, fabrication, dyeing and apparel. Likewise the chain of apparel is distributed to the supply network; production process (factory); and customer order/delivery process (distribution). In other words, the process of customer orders and production is named the order fulfilment process by Kritchanchai and Wasusri [10]. To understand the *apparel supply chain or apparel chain*, at the first stage many small, medium, and large (SML) companies face long lead times and their products are identified to map business processes. Subsequently factors and supply chain strategies, leading to lead-time reduction, are conducted. After surveying, most apparel companies are nowadays classified as a make-to-order producer since their products, such as shirts, are fashionable but some still produce repeat or make-to-stock products such as T-shirts and basic uniforms.

Supply Network

There are two policies in the apparel chain: Make-to-Stock (MTS) and Make-to-Order (MTO). The MTS policy is allocated for a wide range of raw materials and accessory types. On the contrary, a small variety of them employ the MTO policy. Those companies schedule by a combination of first-in-first-out and due-date strategy to reserve the capacity of production and suppliers for customers' satisfaction. Although any customer can reserve its capacity for a time period, its capacity cannot be released to others unless raw materials and accessories arrive on time.

Production Process

The typical production process of seven apparel companies can be divided into the stages of design, grading and marking, fabric cut, assembly (seam), and inspection packing. More detailed findings suggest that product variety most likely takes place in:

- Stage 1: Design. This stage is obviously where product variety begins. The designer will prepare numerous styles of garments. Some basic styles may require less time while more complex styles may take longer.
- Stage 2: Grading and Marking. In this stage incoming materials are marked according to pattern. Product variety is due to the design, style of the apparel product, and the use of different types of material, e.g. cotton jersey (for T-shirt), silk, etc. Processing times may vary depending on the style and material types such as a Chess pattern.
- Stage 3: Cutting. In this stage, materials are cut into different pieces according to the

mark. This is a process conducted manually. Changes from one type of product to another mean that the cutting staff need to inspect the marks, and get different tools. Thus, a certain period of setup activities may occur when it is different.
- Stage 4: Assembly (Sewing). Different pieces of a garment are sewn to create a finished apparel.
- Stage 5: Packaging. Different customers may require specific packaging

Linking to the solution of customised orders in depth, the production process is in the following section in part of the simulation model.

Customer Order/Delivery Process

The finished products will be shipped to the customer, that may be a distributor or a retailer, but not an end customer. Nevertheless, the term 'customer' refers to the end customer, that is to say, the consumer or user of the customised apparel.

3.1.2. Analysis from Observations of Seven Firms into MC Levels

The reason to support the selection of seven Thai companies to study is because they show all levels of MC although some levels are not found in real situations. Their customers are a well-known company and independent shops as retailers. From interviewing companies that represent Thai small, medium and large (SML) companies, this industry needs workers for every process. Most SML manufacturers are often blamed as the weak link of the apparel supply chain after mapping an as-is model, by tracking orders from customers. It is found that most apparel manufacturers are not currently able to provide quick response replenishment. From surveying, all companies are almost completely original equipment manufacturers. Few companies start as an original design manufacturer except for a company (named X), or even other levels of MC. All of them are part of the internal (back end) processes, but there are no companies in this industry linking into the external (front end), MC processes or the product catalogue; design-to-order and assembly-to-order. It is interesting to study how to advance both of them. In brief, there are three kinds of apparel industries from surveying seven Thai companies: Mass-produced products (more than 70% of the firms); Tailored-made products including one-piece production; and Catalogue products that are remarkable catalogue products of shirts that are ideas only.

3.2. Supply Chain Improvements

When product variety comes into the chain, those companies recognize that it is essential to find out a way to manage it, but this was difficult until now. Nonetheless, the problem solutions of the apparel chain are put forward in this section. A future system should be proposed to eliminate long lead times and other relevant problems such as raw material sourcing, information management, production planning and inventory control, quality, and performance measurement. Before doing mass-customised apparel, a firm needs to assess its readiness from a design checklist by Sirovetnukul et al. [11] to reduce preliminary problems.

To achieve MC, many companies are shifting their supply chain policy from MTS to MTO when a customised order gets into the supply chain. There are several popular supply chain strategies or drivers to deal with the challenge of mass-customised apparel. They are divided into customised products and processes. On the one hand, modular customization, dimensional customization and adjustment customization are drivers for customised products. *Modular customization* reduces the variety of components while offering a greater range of end unique products. Modular product design supports a way to provide variety and speed, thereby, enhancing the customization responsiveness. Modularity in the product design facilitates flexible manufacturing systems for low cost customization through fast set-ups. *Dimensional customization* refers to permanent dimensional change such as cutting-to-fit or tailoring. This way of customizing can be performed automatically by computer controlled equipment such as single ply cutting for apparel. The machines can be controlled by programs which can be changed instantly, providing a high flexibility for the manufacturing process. Automatic pattern adjustment, automatic marker making and automatic fabric cutting help dimensional customization for apparel. *Adjustable Customisation* provides the ability of the product to be customised by adjusting the features. Adjustments can be manual such as an

adjustable cloth wriststrap set. An advantage in this customization is that it can still be mass-produced without having to forecast choices. It can be buillt in many versions of products. The companies have also tried to use the adjustable customization technique to customize apparel. For example, user control manual adjustment can be a waistband adjustment of pants using a band-button attachment. Other principles for customised processes are postponement and standardisation. *Postponement* consists of differentiating a product at the latest possible point in the supply network. This point is called the customer order decoupling point. The point is set where the process is decoupled from mass production to customised production. *Standardisation* is a mass customisation technique that provides product flexibility for the production system. Standardisation of parts and materials is an important prerequisite for the build-to-order and MC which will simplify product development efforts, lower costs of parts, material and overheads, simplify supply chain management, improve availability and deliveries of materials, improve serviceability, give fast response, have easy material management and reduce manufacturing complexity [12]. The standardisation strategy for apparel needs to be addressed in a different way than other products as there is a fashion element involved in the product itself. For example, instead of allowing the customer to customise the style and placement of a monogram in unlimited ways, the manufacturer can offer some styles and determine the common style so that customised manufacturing can be simplified. Standardisation can be done in relation to sewing thread (to limit thread type for shirts with appropriate colours), fabric and colour (to limit fabric type and colour), feature types (to limit collar and cuff style options) and fit (to limit fit). Ultimately, it is necessary to study these existing techniques further for whether they can be used and how they can be expanded further in the apparel industry.

Moving from the qualitative problem to the quantitative problem, the problem solutions for customized garments on apparel production systems are illustrated in the simulation section.

4. Simulation Method

4.1. Nature of the Simulation Study

A simulation study may be aimed at evaluating system performance under various possible values of the relevant parameters or at obtaining the best policy to be applied in a system under study. Based on this framework and several papers simulating operations and practice, the simulation model developed in this study is also classified into dynamic, stochastic, and discrete, called Discrete Event Simulation (DES) [13]. This research selects to study and run customised demand in apparel production systems because Reiner and Trcka [14] pointed out that an analysis of a supply chain must be very specific.

4.2. Problem Formulation

Findings from the empirical study involving seven apparel companies in Thailand show that in general, Thai apparel companies produce in a traditional mass production systems or a progressive bundle. These findings are used to develop the MC model that in particular represents a generic MC apparel production system. This problem cuts part of the supply network and production or the order fulfillment process of Kritchanchai and Wasusri [10] to study and focus on the direction of MC. The aim of this section is to investigate all possible characteristics of the apparel production systems. So far, no company in Thailand has applied an MC system that can be used as a benchmark. Therefore a model is designed to represent a plausible MC apparel system. The best method to do this is by developing a hypothetical simulation model. This is the main justification for the use of this simulation model in this study. The MP system will be modelled, completed and compared to achieve the objective of the study on the sample shirt company. The first model represents the current apparel production system, called the **base case or MPAPS** model. The second model is an intriguing MC apparel production system, called the improvement or **MCAPS** model. Several experiments will be done to compare and move from the current mass production system to the new mass customization system. In the following section, the development of the simulation models will be described.

4.3 Simulation Modelling

4.3.1. Input Parameters

In a traditional mass production system, a mass-produced apparel order is generated in certain batches, i.e., each order could have a

quantity (volume) of more than one thousand pieces per day as the planned production rate, but the actual production rate is less than a few hundred pieces per day. In another way the volume of each customised order is assumed and generated in the pattern of casual and fashion at a rate less than three hundred pieces and twenty pieces, respectively, from interviewing. Each order should be unique for the ideal MC concept [12]. A mass-customised apparel order, related to the allocation of raw materials and component parts, is the combination of mass-produced styles and customised features at the assembly point, i.e., Construction; Emblems, Logos, Prints and Photos; Monograms; and Decorated Stitching. Its characteristics are shown in Table 1 and are composed of style types, frequency of style change, and volume of an order.

Table 1. Characteristics of a mass-customised apparel order

1. New	1 - 2 weeks
2. Standardised (e.g. construction)	1 - 6 months > 6 months
Minimum 1 piece 30 pieces (less than 30 plus a surcharge) Maximum 4,000 pieces	

Furthermore, the processing time is a variable depending on the complexity of the product. To reflect this, it is possible that processing time for each order in each stage of production varies according to a certain distribution or is assumed to be a constant. MCAPS is developed to represent a generic apparel production system in case of MC; consequently, some quantitative real data cannot be used in the simulation. A reference set of input data is normally established to develop a reference state against which the results of the experiments can be benchmarked [15].

4.3.2. Decision Parameters (Simulation Environment)

The Make-Through system (or craft manufacturing) uses a highly skilled operator to make one garment for entire processes at a time. This system is required in custom clothing that is lower productivity and higher costs than mass-produced production. This illustration is a reason why other characteristics of different apparel production systems, or sewing systems are described and compared. From surveying the apparel industry spread over the entire U.S. [9], many variations of old and new systems have been defined and named with an array of terms, i.e., Straight Line (SL), Bundle System (BS), Progressive Bundle System (PBS), Transporter System (TS), Unit Production System (UPS), and Modular Production System (MPS). Various classifications of sewing systems have been designed to meet the variety of production needs for the last decade. There are a few papers comparing some attributes with a pair or a couple of sewing systems. To succeed, the target of extending MPAPS and flexible specialization apparel production system in approach to MCAPS, the attributes which are significant for the classification of the entire apparel production systems, need to be studied and identified. These parameters must be decision variables that a company can manipulate. The relationship between some attributes and all sewing systems is exemplified in Table 2. These factors have an influence to decision parameters in simulation. However, there is a paper [9] helping us cut off some systems. From introduction of new styles into the production environment, it is noted that producers have at least three choices of sewing systems (BS, PBS, MPS, and other sewing systems), available to produce garments. The gap of that paper does not refer to which sewing system is best due to lack of relationships among style types, sewing systems and dimensions of strategy at the same time, but compared an individual couple. It is not reasonable to conclude that PBS and MPS are representative for MP and MC, respectively, but MPAPS and MCAPS should be refined from discovering all previous attributes. Finally, it is not easy to build both of them because there are differences of apparel production system definitions that have not been clearly specified in the same direction, but their results are likely to illustrate what happens if customised orders run into these systems.

Some decision parameters from simulation papers [16,17,18,19] are as follows:

- levels of operator skill,
- number of workstations,
- processing times,

- production cost,
- and batch sizes.

Other operational characteristics with no division into decision parameters and resources from some papers [20,21,22,23,24,25] in the apparel industry are:

- multi-function worker,
- teamwork setting,
- high potential machines,
- sewing-skilled worker,
- WIP levels at each station,
- operator utilization,
- relationship of the operator to machines,
- operator performance variation and learning effects,
- machine utilization or machine failure (breakdown) and repair,
- operator absenteeism,
- and knowledge-based supervisory control.

4.3.3. Output Parameters

Time such as lead time or throughput time, waiting time and idle time is considered to be an output performance measure that is one part of four MC apparel performance measures, that is, time, quality, cost and flexibility [2,9]. However, other effects of customised orders, work-in-progress (WIP), machine and operator utilization, and production rate are also measured.

4.3.4. Scope of the study

There are four limitations that are preliminarily determined in the part of simulation modelling. First, the mass-customised men's shirt order is defined by a combination of features but not from the individual end user. Secondly, additional features are selected to study on both construction and ornamental stitching only. Thirdly, production scheduling cannot be optimized due to customised orders scheduled by a customer's production order as the first-in-first-out policy. Finally, raw materials and accessories are regularly delivered on time.

4.4. Simulation Experiments

Several sets of experiments will be conducted. These sets of experiments illustrate the difference between MPAPS and MCAPS while customized orders and decision parameters under apparel production systems are varied. The validation of the possibility of simulated production has been tested by comparing the model's output to the real data of an apparel firm that produces men's business, casual and fashion shirts.

4.5. Experimental Results

The expected results from the simulation study are explained with the characteristics of MPAPS and MCAPS, illustrated in Table 3. These sets of experiments are as follows:

- Experiment on the progressive bundle system;
- Experiment on the progressive bundle system with an MC concept;
- Experiment on the modular production system;
- Experiment on the modular production system with an MC concept.

5. Discussion and Conclusions

The research of MC lacks an accumulation of reliable findings in practice and quantitative simulation. The challenge for this research is how to fulfill and link the weakness of the MC apparel industry. As the field of MC matures, the study has changed from perceptions to actions with real information and virtual data. After mapping business processes in the As-Is section to find out mass-customised problems, there are three kinds of garment industry from surveying seven Thai companies, i.e., Mass-produced products (more than 70% of companies); Tailored-made products including one-piece production; and Catalogue products (but it is remarkable that the catalogue of shirts has not been found). In addition, these companies do not understand how to manage customised products but do away with the IE problems such as line balancing and statistical process control. Thus, it is a good time to fill in this loophole. In the qualitative problem, all of them are essential to solve customized products using some techniques in the supply chain improvements section. For the quantitative problem, this paper proposes the directions of doing simulation modelling towards the apparel production systems but does not include in-depth experiments.

Table 2. Comparisons of attributes of apparel production systems

Attributes	SL	BS	PBS	PBC	TS	UPS	MPS
Style Type	One style	A few styles	A few styles	Various styles	Small size products	One style	Various styles
Volume	Low (Craft)	Large (MP)	Large (MP)	-	-	Large (MP)	Low and Medium
Team/Number of Operators	-	-	55-60 (large line) 20-30 (small line)	-	-	20-40 without team 15-20 with team	7-15
Batch Size (Product Unit)	Single 1	Large (L)	L & Various 30-50	L & various	-	A few 1-3	1 for stand 2-5 for sit
WIP	Very low	High	High	High (need extra space)	High	Lower than BS or No WIP	Very low
Number of Tasks per an Operator	All tasks	One operation 1	One operation 1	-	-	One operation 1	Multi tasks and multi M/C
Machine Capability	No Extra M/C	-	Similar M/C and common feature	Group of similar M/C interchanged	-	Fixed M/C	Small cluster of M/C and special feature

Table 3. Expected results of generic simulation model development for MPAPS and MCAPS

Group of PV (Customised order)	Attributes of Apparel Production Systems Performance metrics						MPAPS or MCAPS (Outcomes)
	Lead Time	WIP	% Util. M/C	% Util. Op.	Prod. rate	etc.	
1. ???							
2. xxx							
3. ***							
4. +++							

In the following paper, the simulation environment described in the previous section will be developed using DES under ARENA software to discover the most appropriate characteristics of MPAPS and MCAPS.

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