Part Family Formation of Ethiopian Cultural Clothing by using Group Technology Coding System

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Abstract

This research mainly focuses on proposing an appropriate classification and coding system for Ethiopian cultural clothing. Previous research has been conducted and a suitable classification and coding system was recommended by different researchers. And this is the first research in its kind that applied the concept of group technology to improve performance of small and micro enterprises that produce cultural clothing. The current small and micro enterprises that produce cultural clothing are applying an informal grouping technique. Because of this, they spend too much time to design, set price, explain the property of the product to customers, and retrieve an already designed parts. In order to investigate this fact, samples of 111 small and micro enterprises that produce cultural clothes around Gulele sub-city were studied. To conduct this study questionnaire, semi-structured interview and observation were employed. The information gathered by questionnaire was analyzed by SPSS software to analyze the producers' perspective on grouping similar parts together. The result indicates that the producers' believe that if their products are grouped together it will save the time they spent trying to explain about the product. The codes will enhance better productivity by enabling the producers to estimate precise selling price; with the symbols representing the characteristics of a certain product. They can also be ued to document a specific design and retrieve it for later use. This act will enable the producers to eliminate duplication of effort by designing the same part more than once. DCLASS coding system is adopted and customized to classify and code parts of the cultural clothing. A database is developed to store the designs of these parts and use it for retrieval in the future. Future researchers can classify and code other textile products and they can develop another classifying and coding technique that represents the parts more than DCLASS coding does.

Key words: Ethiopian Cultural Clothing, Group Technology, DCLASS Coding

1. Introduction

1.1. Background and Justification of the Study

Ethiopia is a country that has more than 80 nations and nationalities with their own language, culture, clothing and living tradition (https://www.amu.edu.et/). Out of the many different special characters of the Ethiopian people, this study will focus on one of the cultural clothing attributes of this country (Tibeb) that is currently being produced at Gulele Subcity, in Addis Ababa. Tibeb, one of the traditional clothing, is cherished and worn by most Ethiopians. It is a special garment favored by people all over the country. Its grace is known by the Ethiopian people and appreciated by the world. There are many small and micro enterprises producing cultural clothes mostly around Shiro meda.

In the international textile and apparel market, supply exceeds the demand as a result, the textile and apparel industry becomes buyer market and the international price for textile and apparel shows a downward tendency (Yared, 2010).

The newly designed cultural clothes were designed and produced by handloom weavers and garments. And these products are being sold in different shops around the city. Meanwhile the performance measures of these traditional clothes are affected by quality, flexibility, technology and customers. The above listed factors highly influence the industry's competitiveness in the global market. Since most of the cultural clothing that are currently found in the market are trending fashions, this fact will affect the industry, because producers are expected to come up with new designs before the current designs start to feel outdated from the customers' perspective. Therefore, improving the performance measures of these fashion firms will highly increase the competitiveness; profitability and satisfaction of customers in the Global market (Messele Kassaw, 2013).

In addition, Selamawit (2016) pointed out that substitute and supporting industries highly affect the competitiveness of this industry. The competitiveness of Ethiopian cultural cloth making industry is also

influenced by lack of designed product distribution mechanisms, shortage in supply of appropriate raw materials with fair price and lack of modernized production and machine technology. The key areas whereby problems were identified are low quality, poor knowledge of products by consumers and low demand. Role of government is to follow the demand conditions that affect the competitiveness of the industry. There are good polices that supports the industry but the implementation of the policies is not effective. It was also found out that those producers of cultural cloth making industries around Gulele subsicity lack sufficient skills to compete.

In a situation where the international cultural cloth market is being dominated by the Asian cloth makers, the Ethiopian cultural cloth should also be promoted and sold to the foreign market. But before doing that the cloths should be standardized according to their specific design in order to meet the needs of the customers and set a reasonable price. In order to help this cultural cloth making business, product coding technique of group technology will facilitate in clustering cloths having similar features, materials, dimensions, geometric shape and other characteristics.

There are different designs of clothing being produced in these SMEs, as a result this study investigated and group these different types of designs according to their similarity for the selected micro and small enterprises. Since the clothes that are being produced currently are not informally grouped, the price set for similar clothing differs. This thesis is expected to assist the producers in identifying the similarities between different designs of cloths and set an appropriate price for the customers. At the same time, different designs of clothing will be documented for later use. This task is expected to increase customer satisfaction and minimizing the amount of time customers spent to choose different features in a single product. In addition, the cost of producing the cloths and the respective profit margin will be identified clearly.

Group technology (GT) is drawing increasing attention from manufacturers because of its many applications for improving productivity. GT in cellular manufacturing systems (CMS) is very

important to improve productivity for manufacturing industry. Group technology (GT) can be considered as a simplified methodology which categorizes standardized similar entities into groups such as parts, assemblies, process plans, tools, instructions, etc. to reduce the time and energy and to improve the overall productivity for batch type production (Burbidge, 1963). According to (Guerrero, et. al., 2000) a successful implementation of GT could eventually minimize the engineering costs, facilitate cellular manufacturing, quicken product development, improve costing accuracy, simplify process planning, minimize tooling cost and simplify the entire purchasing process. The main precondition in implementing GT is the identification of part families (Kaparthi, et. al., 1991). A part family is a group of parts sharing homogeneous design and manufacturing attributes. Early research in this domain has been devoted primarily to the formation of production-oriented part families in which similarities amongst the parts are principally recognized on the fact of their processing requirements, operation time and operation sequences. Though, these methodologies are inadequate in achieving the needs of other extents of manufacturing. For instance, parts with similar shape, size, dimension or other design characteristics are believed to be clustered in a single family for design justification and elimination of part varieties; however, parts which are clustered on the fact of similar routing and the tooling needs are convenient to resolve the process planning issues.

As a result, the scope of this domain of research is believed to be expanded and examined to a wider span of part similarities. Part similarities are believed to be identified sooner than the formation of part families. Part attributes such as shape, length/diameter ratio, material type, part function, dimensions, tolerances, surface finishing, process, operations, machine tool, operation sequence, annual production quantity, fixtures needed, lot sizes have been considered as the basis for similarity utilization (Groover, et. al., 1984). The complexity remains in acquiring an appropriate technique which provides an identifying competence of human being, such as identifying patterns in groups, and forming part families with the aid of intelligence (Moon, 1992).
This article depicts three different part family identification techniques based on Complete Linkage (C-Linkage), Single Linkage (SLCA) and

K-means clustering algorithms to investigate the nature of similarities and to describe the effectiveness of the techniques in solving the problem in hand.

1.2. Statement of the Problem

SMEs that produce cultural clothing are implementing an informal product classification technique. According to the information gathered from semi-structured interview, the problem identified for these cultural cloth producers regarding the implementation of group technology is that operators will design different types of clothing according to the demand of each customer. While they do this every time a customer wants a slightly modified product or a completely new design, the producers spend too much time. They spend much while describing about the products to their customers and negotiating price. In addition to this, the previously modified or created design is neither documented in a computer nor is kept in a printed format to retrieve for later use.

Figure 1: Informal arrangement of Tibeb kemis and Netela parts

As shown in figure 1 above, the designs of parts are different. And it will be hard to find the part a customer is looking for. Because of this practice, parts are not exceptional; and the greatest advantage of GT comes through a formal coding system in which each part gets a numeric or alphanumeric code describing the attributes of importance (Nancy, 1984).

Application of GT in small organizations will assist them to achieve process competence and better process control. It will also enable them to manufacture highly accurate products and get price advantage on these value added products as they grow through forward integration (Murray, 1984).

1.3. Research Questions

1.3.1 General Research Question

Which coding system can best represent the Ethiopian cultural clothing into part families?

1.3.2 Specific Research Questions

Specific questions of this research are:

a. How are the products (different designs of cloths) being grouped in the selected SMEs?
b. What things are missing when the producers' group their product without using group technology?
c. How is the selected grouping system going to assist the produces' of the cultural cloth making industry for a successful activity?

1.4. Objectives of the Study

1.4.1 General Objective

The main purpose of this project is to select and form a part family for Ethiopian cultural cloths having similar features, dimensions, geometric shape, materials and other characters. A suitable coding system for the Ethiopian cultural clothes is applied after the characteristics of the cloths made around Gulele Subcity are studied in depth. This study is expected to assist the producers in identifying the different features of the cultural clothes that makes them similar to each other. After the product design system is studied for the selected SMEs problems, classification and

coding of product families is conducted. And the appropriate product coding system of group technology is implemented for this specific case.

1.4.2 Specific Objectives

Specific objectives of this thesis are:

a. Examine the product categorization activities being followed in the SMEs.
b. To investigate how the products are grouped in cultural cloth making SMEs and identify the gap between the product family formation techniques of group technology and the one that is currently being applied in the selected SMEs.
c. Propose an appropriate clustering system through application of group technology that facilitates better performance of the producers to fill the gap.

1.5. Delimitation/Scope of the Study

There are different manufacturers and designers who design, produce and sell cultural clothing in Addis Ababa. This study focuses on application of group technology, coding system by using the design aspect of Ethiopian traditional clothing. The study area is located at 'Gulele subcity' which is the main destination for manufacturing and marketing the cultural cloths in Addis Ababa region. In order to have a better understanding about the features of cultural clothing, two designers were contacted and the research is considering only tibeb among the vast variety of cultural clothes of Ethiopia.

1.6. Significance of the Study

The significance of this study is that products that have similar features are identified and grouped into a part family. This grouping procedure will help the buyers and sellers to spend minimum amount of time when selecting a specific design and negotiating price for a certain design of cultural clothing. This is because the codes clearly describe the attribute of that specific cloth ensures the seller to offer the accurate price. The different designs that are being modified by the cloth makers will be

recorded along with the current ones. In addition, the cost of making a certain cultural cloth and its respective profit margin will be estimated precisely. It will also avoid duplication of effort, while enhancing simple and timely information retrieval and use of the documented design. In addition, the proposed coding system for tibeb, gabi and netela can be adopted to classify and code other cultural clothing of Ethiopia and other textile products. This research will also contribute to the literature of group technology, since it being applied to textile industry. No other previous research on group technology has been applied to textile industry so far.

2. Research Design and Methodology

2.1. Research Design

This research was designed to identify similarities between different designs of cultural clothing. In addition, it is designed to investigate how these clothes can be grouped into a family that represents the clothing's characteristics.

The research was based on information gathered through a questionnaire given to producers of Ethiopian cultural clothing of the selected SMEs. In order to reach these respondents, questionnaires were given to the manufacturers by the researcher. The period over which the survey took place was March and April 2016, and samples of 111 respondents were obtained.

The questionnaire was delivered to the respondents in person and they were requested to complete it within a minimum number of days. Regarding appropriate sample size for factor analysis, different rules in the literature are indicated. Comrey et. al., (1992) considered the sample size of 100 as poor, 200 as fair, 300 as good, 500 as very good and 1000 or more as excellent. As a result, a sample of 111 respondents are studied for this research from randomly selected SMEs that produce cultural clothing.

All respondents were males. Regarding appropriate sample size for factor analysis, different literatures indicate that the sample size should at least

be 100 Gorsuch (1983) and Kline (1994), and the higher the number of samples the more accurate the sample will represent the entire population.

2.2. Population and Sampling Techniques

This research was studied on 111 different SMEs that produce cultural clothing around Gulele sub city.

Table 1: Number of SMEs producing cultural cloths in Gulele Subcity (2008 E.C)

Name of the site	Number of Enterprises	Samples	
Kechene Aregawyan Site	7	3	3%
Kundish Site (Shiromeda)	75	51	46%
Mintamir Site	32	24	22%
Mela Engineering Site	7	3	3%
Gulele subcity Addisu Gebeya Shema Maekel Site	3	2	2%
Gud Semerita Site	27	18	16%
Andinet Yimret Site	13	10	9%
Total	154	111	

Source: Gulele subcity document

The sample for each population was estimated considering 95% confidence interval and 5% error http://www.research-advisors.com/tools/SampleSize.htm.

$$n = \frac{N}{1 + N(e)^2}$$

Where **n** is the sample size, **N** is the population size, and **e** is the level of precision or expected error. By using this formula at 95% confidence level and 5% level of precision the sample size was as follows: -

$n = 154 \div (1 + 154(0.05)^2)$

n= 111 samples

2.3. Types of Data and Tools/Instruments of Data Collection

The research instrument, developed and used in this study, is a questionnaire having five-point likert rating scale 1-Very poor, 2-Poor (disagree), 3-Fair (Neutral), 4-Good (agree), and 5- Very Good (strongly agree). The questionnaire was developed on the basis of literature (Mitrofanov (1966), Burbidge (1996), Offodile, (1992), Singh, et. al., 1996, and Han and Ham (1986)) which identified critical areas of a product feature.

Producers were interviewed by making a basis on a semi-structured interview questions. The semi-structured questions were starters for the conversation. Respondents also asked to answer to additional questions at the scene of the interview session.

2.4. Procedures of Data Collection

Before collecting primary data from the respondents' letter for cooperation was written from the university and shown to each enterprise. After the letter was approved the questionnaire was given to the enterprises and collected in the next days. The date for submitting the questionnaire was decided by each employee/respondent. Therefore, the researcher respected this decision of each respondent and received the questionnaire as promised.

The semi structured interview took place when the respondents the completed questionnaire. Luckily, all were willing to be interviewed at the time of request. And if they were busy, they delegate someone to be interviewed.

In addition to the above, observation played role when it comes to identifying similar attributes across different designs of cultural clothing. Observing is the substitute term for visual inspection in this case. This is because the characteristic of products is identified by looking at each product. This is one of the methods whereby the unique features or the characteristics that make each product different from the other were identified.

2.5. Methods of Data Analysis

The survey data obtained through questionnaire included items addressing correlation between similarity of materials, size, shape, process, part family and product coding techniques. As a result, the information gathered from the questionnaire was analyzed by using software program Statistical Package for the Social Sciences (SPSS) for statistical analysis.

And the information gathered by the means of semi-structured interview was analyzed to group the products into family that share similar attributes.

2.6. Ethical Considerations

Since people have the right not to be forced to participate in studies, the researcher gave each respondent a chance to decide whether or not they would like to contribute to this research. When they were answering questions from the questionnaire, the researcher was there to ensure that the respondents are aware that the information collected would be used for an academic purpose only. The researcher also ensured that participants could respond to the questionnaire at a time that is most convenient for them and stick to the time decided by the respondents. The researcher ensured that the questionnaires that should be copied to SPSS software for analysis has be answered completely.

3. Results & Discussion

3.1 Results/Findings of the Study

3.1.1 Types of Products

There are different types of products being produced in these SMEs around Gulele Sub city. The following table shows the characteristics of these products.

1. **Gabi**: **(ጋቢ)፡** It is a large rectangular piece of thick clothing usually worn in cold weather There are two types of gabis classified as netela

(ነጠላ ጋቢ) and mulu gabi (ሙሉ ጋቢ). The above classification is based on the thickness of each gabi. The mulu gabi is thicker and will warm a person wearing it more than a person who wore the netela gabi.

$$Size\ of\ mulu\ gabi = 0.85\text{m} - 2.75\text{m}\ \text{x}2.9\text{m} - 3\text{m}$$

$$Size\ of\ netela\ gabi = 0.85\text{m} - 2.75\text{m}\ \text{x}2.9\text{cm} - 3\text{m}$$

The size of 'Netela Gabi' is two times the size of a scarp (1.5m*3.6m) whereas the size of 'Mulu is four times the size of a scarp (3m*7.2m).

Figure 2: Gabi (Source: www.google.com/)

Size of Gabi (0.85m-2.75m x2.9m-3m)

2. **Netela (ነጠላ)**: It is much similar to Gabi, except it is usually worn for funerals with black tilet on its border. During funerals it will be worn by bringing the side the netela whereby the tilet is shown on the head. The dominant color of netela worn for other occasions including to church can be any color other than black. Customers can wera the netela with a black tilet even if it is not for mourning. In this case the side that has tilet will be facing the ground when it is worn. When the netela is worn with a tibeb dress, the tilet for both netela and the dress are identical. Netela is also worn by men and women, and the designs might differ.

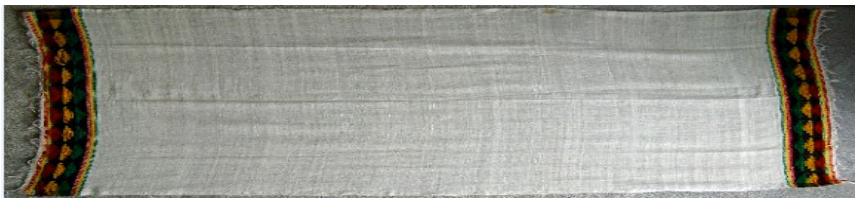

Figure 3: Netela (Source: www.google.com)

3. **Scarp (ስካርፕ)**: It is a small rectangular piece of thin clothing worn around the neck. It will have tilet like gabi and netela. What makes it different is only its size. And it is further classified as large and small sized scarp.

$$Size\ of\ small\ scarp 0.75m * 1.8\text{m-}2.2\text{m}$$

$$Size\ of large\ scarp = 1.35 - 1.5 * 1.8 - 2.2$$

4. **Cultural Dress/Tibeb Kemis (ጥበብ ቀሚስ):** It is a unique dress that is made by Ethiopians who have the skill of operating a hand weaving machine. The shape of the dress is similar to other dresses that are worn around the world. But the materials these dresses are made of and the aesthetic features included to attract customers is very unique. Tibeb kemis can also be categorized according to its size ranging from 2arb up to 6arb. Arb is a unit used to measure the size of any cultural clothing by the hand weavers around Gulele sub city, Addis Ababa. Dresses with a size of more than 4arb are usually worn for special occasions; including wedding.

$$1arb = 0.75m * 1.5m$$

$$2arb = 0.75m * 3m$$

$$3arb = 0.75m * 4.5m$$

$$4arb = 0.75m * 6m$$

$$5arb = 0.75m * 7.5m$$

$$6arb = 0.75m * 9m$$

In addition to the sizes stated above, dresses are also made for little girls. As a result, the size will be much smaller when it is made for children.

5. Table clothing (የጠረጴዛ ልብስ): The SMEs that produce cultural clothing for people to wear also make very unique table clothing. The

shape will be determined according to the shape of the table it is produced for, including rectangular and oval. Its size also varies according to the size of the table. Even if the size of the table clothing didn't have a well known dimension like the above products, the common dimension that producers made so far includes:

$$Size\ of\ table\ clothing = 0.3m - 0.5m * 1m - 1.5m$$

6. **Cultural Curtain (መጋረጃ)**: This is another type of product that is made by SMEs around gulele sub city. Its dimension is not well known by producers that were studied for this sample. As a result, it was difficult to estimate its standard size.
7. **Bed mattress (የአልጋ ልብስ):** It is also another type of product produced by sharing the characteristics of Tibeb; because it will have tilet or tilf to make it different from the ones produced in a modern factory.
8. **Pillow (የትራስ ልብስ):** The pillows are of made for bed and sofa. Their size varies according to the size of the actual pillow of the customer.

$$Sixe\ of\ pillow\ clothing = 0.4m * 0.4m$$

9. **Sofa clothing (የሶፋ ልብስ):** This is the clothing made for the sofa to cover the main clothing it was made of.
10. **Male trouser (የወንድ ሱሪ):** Trousers for male are also being produced.

$$Size\ of\ male\ trouser = 0.75m * 0.8m$$

In addition to the size indicated above, male's trouser is also made for boys with a much smaller size.

11. **Male vest (ሰረዲያ)**: The vest is also another type of product that is produced in the SMEs both for men and little boys.
12. **T-shirt (ቲሸርት):** T-shirts are produced that match with the tilet of the trouser.
13. **Napkin (ናፕኪን):** It is a square of clothing that is used when food is being eaten to protect peoples' clothes from ruining. It can also be used to wipe mouth or hands.

3.1.2 Descriptive Statistics

Descriptive statistics (means and standard deviations) for the main study variables are provided in the table below.

Table 2: Descriptive Statistics

Descriptive Statistics			
	N	Mean	Std. Deviation
G1: Geometric Shape	111	3.5856	.80304
G2: Geometric Size	111	4.0901	.78102
Pr: Process	111	3.9820	.77439
M: Material	111	4.0270	.79154
S: Similarity	111	3.9730	.82528
C: Product Coding	111	4.1171	.81730
Valid N (listwise)	111		

As described above (Table 2) the producers' perspective is shown by indicating the mean and standard deviation.

For the first question that producers of cultural cloths asked was to indicate the advantage of grouping products having similarity in geometric shapes. Then the mean was found to be 3.5856 with a standard deviation of 0.80304. These numbers indicate that producers themselves believe that if netelas, tibeb dresses and gabis sharing similar shapers are in a single part family it will save time for both producers and customers of this industry. As stated in the problem statement section of this manuscript, one of the problems that producers face was the time it took them while explaining about a certain design of a product, and negotiating the final price. If the parts sharing these characters are grouped together, then it will ease the process of estimating the exact price for the product.

The shapes of the clothes can be generally categorized according to their shapers. For instance, gabi and netela can be grouped as having rectangular shapes. And their tilet can be categorized as 'diamond' shaped or 'flower'.

The second question asked respondents if they think that grouping products that have similarities in geometric size will save them time. Size is also one of the factors that influence the price set for a certain product; the larger the size the higher the price. As a result, the producers also think (Mean = 4.0901 and standard deviation = 0.78102) that if their products are grouped together according to the size of the clothing, then it will smoothen the process of explaining why these products are assigned that specific price for the customers. Also, the time that was spent to figure out which size fits a specific customer will be identified.

Figure 4: 4arb sized dress (Source: www.Ethiopianclothing.net)

The setup for all products of cultural clothing is almost the same. For instance, all types of dresses, netelas and gabis can be produced with a single hand weaving machine. But the arrangements of thread used to produce the clothing differ according to the preferred design. The difference can be specially spotted on the tilet of the clothing. Since tilets are categorized as Sherko, Zipe Sherko, Difin and Limut, one can visualize the arrangement of threads. Their difference can be spotted by realizing the concentration of each trade in each design.

Limut design of tilet represents tilet made of a single color and material. This is the simplest type of tilet design. Whereas ‘Sherko’ refers to ‘tilet’ made of a combination of different colors of threads and the way these threads area arranged is different than ‘Difin’.

Figure 5: Sherko Tilet

As shown from the above figure, the ‘tilet’ is made of two different colors of threads. What makes a ‘sherko’ type design is that the strip lines that are seen on the tilet. These strip lines are indicating the space that is shown between the arrangements of the threads.

In the case of ‘Difin’ type of ‘tilet’ the strip lines found on the sherko design will not be shown here. This is because in the case of ‘difin’ type of ‘tilet’ design the concentration of threads is very high. As a result a space will not be left on the entire design.

Figure 6: Difin Tilet

Figure 7: Zipe Sherko Tilet

And the respondents' answer (mean = 3.90820 and standard deviation = 0.77439) shows that they believe that if cloths sharing the same processing technique are grouped together it will definitely save them time and energy spent with customers.

In addition to its design different the time it will take to produce the different types of tilets varies. 'Limut' will take the shortest time when compared to both 'sherko', 'zipe sherko' and 'difin'. And 'difin' design of tilet will take more time to be compeleted when compared to both 'sherko' and 'limut'. This is because the concentration of threads is very high and much care is given to complete the design having high quality. Finally, 'sherko' will take medium amount of time when it is compared to the other two designs of tilets.

For the fourth question the respondents answered that (Mean = 4.0210 and standard deviation = 0.79154) if the clothes are grouped together by sharing the same materials, it will save time for them and their customers. The material the cultural clothing is made of differs with different factors, such as customers' perception. And the materials used to produce tibeb kemis, netela and gabi are cotton, silk, wool and shiney thread that is commonly known as 'werkezebo'. A certain product can be produced by either one type of material or a mixture of different types of materials.

Figure 8: Tibeb Kemis made of silk, cotton and werkezebo

From the above figure 8, it is shown that the above material is made of silk, cotton and shiny material that is commonly known as 'werkezebo'.

The other question that producers asked was to asking them if similarities between these products are identified and grouped together, it will save both time and energy. With a mean of 3.9730 and a standard deviation of

0.82528 they agreed. One of the advantages of group technology is to simplify the system by identifying similarities.

And for the last question, the highest mean (4.1171) with a standard deviation of 0.81730 is found. This value indicated that cultural cloth producers of Gulele sub-city believe that if each product is assigned a code that identifies its characteristics time will be saved. The time duration customers spent looking for a specified design that suits their interest will be minimized. And the time and energy producers exert explaining about a certain product will also be reduced. In addition, the time designers spend to come up with a new draft will also be decrease. Because the when the products are coded, they are documented for later use. And designers can refer to these codes to inspire them for a new idea. In addition, this act will avoid duplication of effort, since an already created design will not be crafted by another person for the second time.

4. Discussion

The collected data through semi-structured interview is organized to form a part family by adopting DCLASS coding system. Before discussing the steps, this section will initially explain the sub elements of each part. For instance, since Netela,Gabi and Buluko have the same general shape they are included in the element called 'Blankets' as shown in the figure below. This is further explained in the DCLASS logic tree in the following section of this manuscript. The parts shown below have a rectangular basic shape.

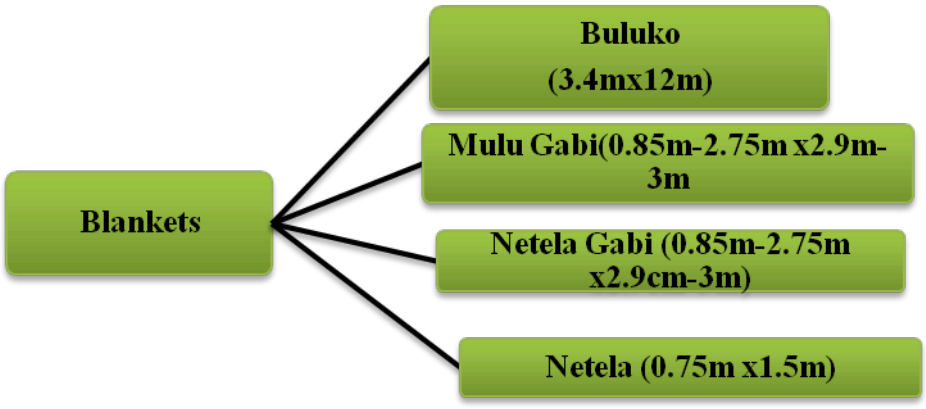

Figure 9: Hierarchical Structure for Blankets of Ethiopian Cultural Clothing

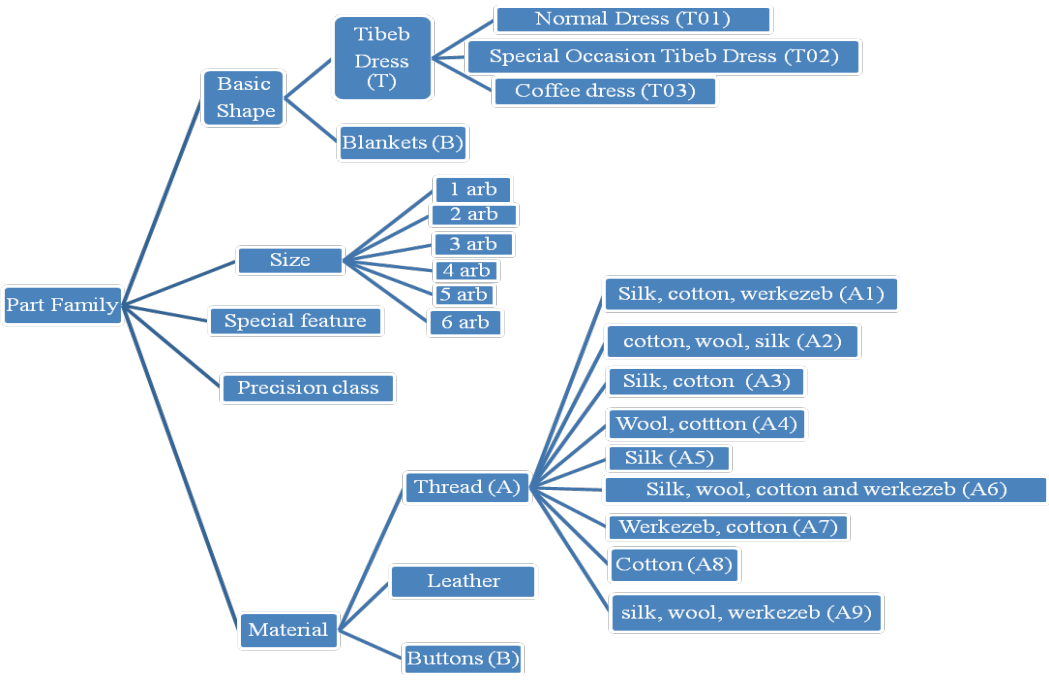

Figure 10: DCLASS Logic Tree

For the above logic tree, the basic shapes of the dresses for the three events (Special occasion, Coffee ceremony and casual) have unique shapes. Even if the tibeb dresses don't have a well-defined shape, the user will definitely distinguish one she wears for the three different events mentioned in the DCLASS logic tree.

For the above DCLASS logic tree T stands for 'Tibeb Dress' and B stands for 'Blankets'. It should not be forgotten that Gabi, Netela and Buluko are included in 'blankets' because these three products share similar basic shape.

Figure 11: Coffee dress DCLASS code of T03326A4

The code for the above dress is **T03326A4.** The first three digits indicate the basic shape of the part. The procedure for getting this code is based on the above figure, which illustrates a DCLASS part family classification chart. Note that this chart is structured as a logic tree. It could have been structured in some other manner, but logic trees are much easier to work with. This is the representation of one of many such charts in the DCLASS coding system. By applying this chart to code the 'Tibeb dress', a path through the logic tree that shows the the types of dresses (Simple, occasional and coffee ceremony) is taken. At this point the first logic tree for cultural clothing is used, indicating that the branches of a 'Tibeb dress have three other branches as shown in the above figure. Unlike the existing illustrations that describe DCLASS coding by examples, the attribute for 'Tibeb dress' regarding basic shape is limited to two digits. Therefore, for the last branch of the above logic tree the code value will be terminated as T01 representing the first three digits of the code for 'Tibeb dress'.

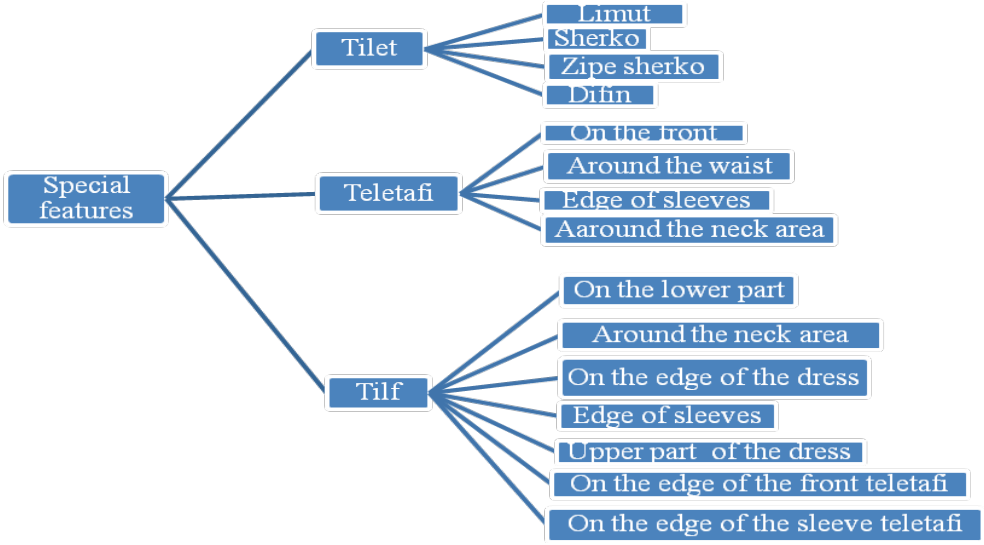

Figure 12: DCLASS Logic Tree of special features

Similar to the above description the second section of part family code describes the complexity of special features of the dress being coded, which is the 'Tibeb dress'. In DCLASS coding system special features of a part include, specifically for this case (Tilet, Teletafi and Tilf). The following table describes the various code values that can be used to code the complexity of the special features. For the above coffee dress, a complexity code of 3 is assigned since there are three special features for this 'tibeb dress'. This is because the dress has three special features, such as tilf on the front of the dress, edge of the sleeve and around the neck area. The above dress does not have tilet or teletafi.

Table 3: Complexity Code for Special Features

Feature Complexity Code	No. of special features
1	1
2	2
3	3
4	5
5	8

6	13
7	21
8	34
9	>34

The third section of the part family code refers to the size of the part. The current coding system is being applied by adopting DCLASS coding system (Table 4). But since the parameters set for existing models for this code are not for textile materials. Therefore, the size codes for this research are changed into the ones shown in the figure below.

Table 4: Original DCLASS Size Code

Size code	Dimension (mm)	Description
1	0.5	Subminiature
2	2	Miniature
3	4	Small
4	10	Medium small
5	20	Medium
6	40	Medium large
7	100	Large
8	400	Extra large
9	1,000	Giant

Table 5: Adopted Table for DCLASS Size Code of Cultural Clothing

Size code	Dimension (mm)	Description
1	1 arb	0.75m*1.5m
2	2 arb	0.75m*3m
3	3 arb	0.75m*4.5m
4	4 arb	0.75m*6m
5	5 arb	0.75m*7.5m
6	6 arb	0.75m*9m

Using the adopted table of DCLASS size code (Table 5), '2' would be used in the code for the 'Tibeb dress'. Precision in DCLASS coding system indicates a composite tolerance and surface finish of a part. The table shown below presents the precision value applied by DCLASS coding system.

Table 2: Original DCLASS Precision Class Code

Class code	Tolerance (inches)	Surface finish (rms/root mean square)
1	<=0.0005	<4
2	0.0005-0.002	4-32
3	0.002-0.010	32-125
4	0.010-0.030	125-500
5	>0.030	>500

The above table is also modified, this is because the precision of the

Table 7:3 Adopted DCLASS Precision Class Code

Class code	Precision	Description (Complexity of tilet)
1	Tilf	Hand embroidered
2	Mixed	Very difficult
3	Difin	Difficult
4	Zipe sherko	Moderate
5	Sherko	Simple
6	Limut	Very simple

The above table 7 lists six classes of precision used for cultural clothing. Limut tilet is the simplest of all the other five tilets, whereas tilf is done by hand and much care is needed to find the desired design. Class 5 indicates very low precision and a part with a precision code of and class 1 requires careful processing. Therefore the coffee table shown above requires high cautious for the product to be completed with the desired quality of design, therefore a code value of "6" is assigned.

5. Conclusions & Recommendations

This chapter describes the major findings and the conclusions of this study. Furthermore, the researcher also indicates recommendations for future study.

5.1. Conclusions

In this research the advantage of part family formation by using group technology classification and coding system are discussed in detail. One of the characteristics of manufacturing system is that, it is possible to take advantage of group technology, even if it is not wholly implemented. As a result, production benefit can be achieved by developing part classification and coding system. This act for the textile industry of Ethiopian cultural clothing indicates that advantage of design retrieval, minimization of duplicated drawings of parts, and minimized operation time can be achieved.

The codes assigned to each part refers to the characteristics of each part implying the advantage of grouping similar parts to overcome the existing problems regarding informal part grouping technique that is being applied in SMEs.

Accordingly, future researchers can focus on developing classification and coding system that best describes its characteristics for the rest of the Ethiopian cultural clothing and other industries. A database is developed to store the parts with respect to the code that represents the parts. The database can also be used as an e-commence to let customers know about the characteristics of a product they desire to purchase. Users can modify the information fed on the database for improvement.

5.2. Limitations of the Study (if any)

As explained in the introduction section of this manuscript, Ethiopia has a large number of nations and nationalities. And these nations have their own style of dressing, clothing and other attributes. From the vast variety of cultural clothing this research is only focused on 'tibeb dress', 'netela', 'buluko' and 'gabi'. Therefore, one of the limitations was the fact that the researcher was not able to study all cultural clothes. In addition, there are different manufacturers of these products, and all the manufacturers were not studied since it only focused on 'gulele subcity'. Two designers were contacted for this study, but exploring the working system of other manufacturers will provide a better understanding about the nature of tibeb. At last,the names of the materials indicated in the coding system are the general terms of threads. Each thread has its own number and characters. Because of the knowledge gap, the researcher was forced to use the general terms for threads.

5.3. Recommendations

First and foremost, applying group technology product classification and coding technique will benefit the SMEs that produce cultural clothing around Gulele sub-city. This is because they can benefit from the advantages of the product classification and coding system. Secondly, future researchers can study the characteristics of other cultural clothes that were not studied in this research. They can also investigate the specific terms for each thread type. For instance in this case we use the term 'werkezeb' for all shiney materials. But each shiney material differs from the other by its characters. Some of them will fade when the clothes are being washed and the color of others will not fade at the same time.

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