

system for exporting goods provided by the European countries and the US for developing countries and cheap labour availability.

There were around 1061 apparel manufacturing companies in Sri Lanka by 2001 and 23% of them were large scale manufacturers who had more than 500 employees [3]. There were 61 extra-large scale companies also among them who accounted for more than 70% of the market share from the Sri Lankan apparel exports [3]. Since then, the garment industry has grown incredibly in just a few years. Currently, there are around 300 large scale apparel manufacturing companies registered in Sri Lanka [4]. About 90% of the market is owned by those 5% large scale apparel manufacturers [4].

According to the above statistics, Sri Lankan economy is highly dependent on the large-scale apparel manufacturers. Therefore, the sustainability and the growth of the industry is very important for the Sri Lankan economy. Same as other countries, Sri Lankan apparel industry has also been exposed to many risks as individual organisations and as an industry. Thus, this study is aimed in identifying and ranking 30 critical SC risks affecting the large-scale apparel manufacturing companies in Sri Lanka which will help with providing focus points for risk mitigation plans to reach optimum effectiveness.

2. Literature Review

2.1 Supply Chain

Different organisations and authors have given different definitions to the supply chain concept. According to the Association for Supply Chain Management (ASCM), the supply chain has been defined in a process basis and a functional basis. As per the process basis definition, according to ASCM, supply chain is the process of linking the suppliers, companies, and users who are engaged in transforming raw materials to ultimate consumption. As per the functional basis definition, a supply chain is the functions inside and outside the company which are engaged in making products or services to the customers [5-7].

The definition of supply chain from the Supply Chain Council also has a functional basis. According to them, the supply chain is a term used to encompass every function, including

plan, source, make and deliver, related to the production of a good or service and the delivery of them from the very first supplier to the final consumer. The functional basis concepts for the supply chain which were mentioned above have been used in this study.

2.2 Company Risk

Risk is a term that has been defined differently in several business functions such as finance, strategy, marketing, management, and psychology. By considering the different definitions from different business functions, some common features can be discovered concerning risk identification as listed below [12].

- What are the risks or losses that can arise?
- What is the likelihood of each loss or risk occurring?
- What is the impact if the risk or loss arises?

The loss can be both quantitative such as loss of sales and qualitative such as loss of brand image. In addition to the above features from different perspectives, there are some objective definitions as well for risk [8-10]. Risk is the occurrence of any undesired disturbance or outcome other than the expectation [8, 11]. Risk is influenced by two major factors called likelihood or probability of the loss occurring and the impact or the significance of the mentioned loss if it occurs. So, an equation can be modelled as mentioned below [12].

$$Risk_n = Probability_n \times Impact_n \quad \dots(1)$$

($n = loss$)

The probability of any risk occurring also depends on the amount of exposure to the risk and the extent of realisation. Some strong businesses can partially or totally influence the risk realisation whereas small scale businesses can only adjust with the risks or the influences from the business environment [5].

The impact of the risks works differently on high growth industries and low growth industries [5]. As an example, the lack of information risk affects similarly on both high growth industries and low growth industries while the risk of inability to reach innovation targets highly affects high growth industries than low growth industries. In general, it is not possible to measure the impact of risks unless the particular organisation has laws and regulations defining the relation.

2.3 Supply Chain Risk

General risk management studies only assess the risk related to an individual company. SCRM is about assessing the risks related to the entire supply chain [13, 14] and the supply chain risks have arisen with globalisation and the inability of the organisations to cope with trends/ firm's consolidation [1]. Highly complex business networks are more likely to face risks related to the supply chain since a greater number of interfaces increases the vulnerability among them [8, 13].

The conditions, surroundings and the forces which lay inside the organisational boundaries that affect the assets, functions or performance of the organisation directly or indirectly, are called the organisational internal environment. The institutions and the forces which lay outside the organisational boundaries that affect the assets, functions or performance of the organisation directly or indirectly, are called organisational external environment [4, 9].

Organisational risks can be divided based on the business environment. They are risks from the internal business environment and the external business environment [2].

Supply chain risk can also arise from both of these dynamic environments. Therefore, this study has been conducted considering the organisational environment categorisation and the organisational risk categorisation [2, 4].

The internal business environment has been further divided into process risk and control risk to simplify the study [10]. All losses occur due to the malfunctions in the business processes are called process risk [8]. According to the definition from International Standard of Auditing, control risks occur due to the malfunctions and the faults of the systems that are used to control the business which include the supportive activities to the value-added services or the main process. Due to the changing nature of the businesses, there is no solid management solution which will suit all the circumstances of the process or control risks in the long run.

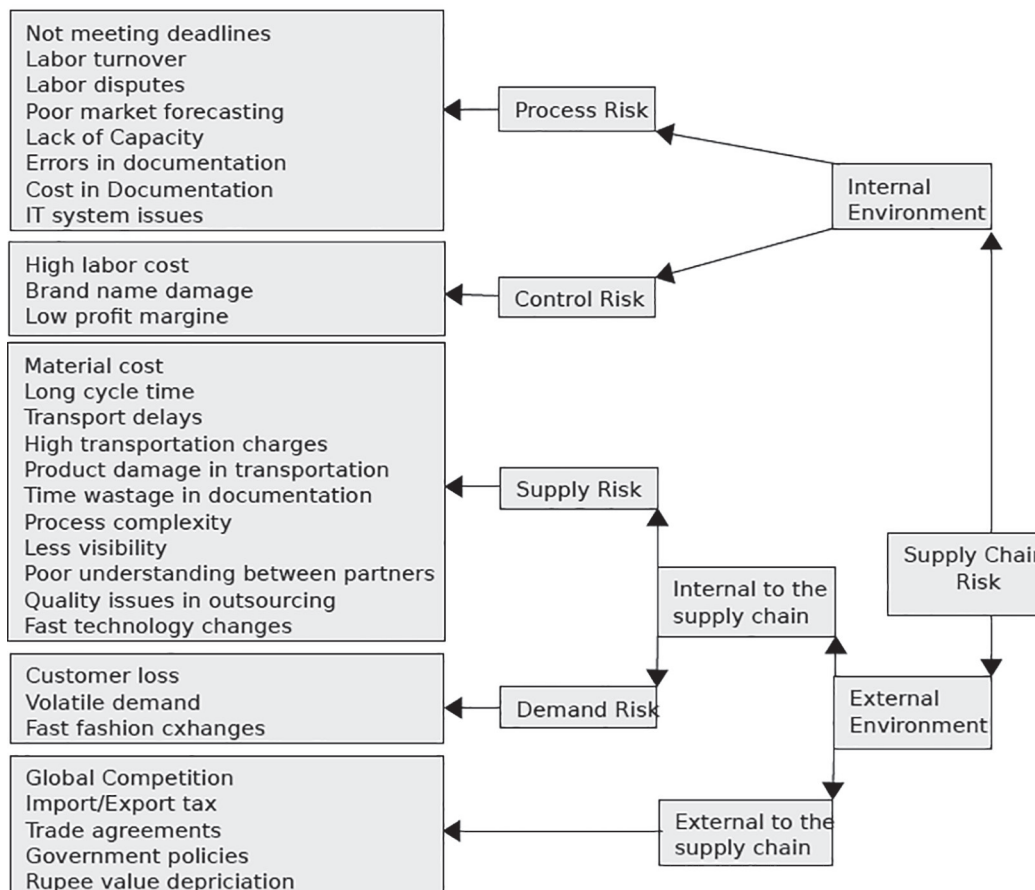


Figure 1 - Conceptual Framework



All these strategies must be continuously reviewed and updated by the decision-makers [7].

Risks from organisational external environment can be further divided into two as “risks which are internal to the relevant supply chain, but external to the organisation” and “risks which are external to the relevant supply chain and the organisation” [15-17]. Risks which are internal to the relevant supply chain but external to the organisation can be further divided into supply risks and demand risks. All the risks related to functions between raw material processing to the finished goods retailer within the supply chain, are called supply risks. Demand risks can be defined as the reasons for the gap between actual demand within a specific time and the expected demand within that period. Forecasting the market demand has been a difficult task for the apparel industry due to the dynamic nature of the economic environment [15].

3. Research Methodology

This study has been built according to the conceptual framework mentioned in Figure 1. This research has an inductive research approach. It was begun by collecting supply chain risk factors in large scale apparel manufacturing companies and then measuring the severity of each factor according to the experience of field experts. Hence, the results of the study state the supply chain risk factors in a sequence according to the severity of them.

This descriptive research evaluated the current situation of 15 large scale apparel manufacturing companies in Sri Lanka and ranked 30 identified supply chain risks according to their probability of occurrence and the loss or the impact of it, if the risk occurs.

This research was developed to yield both exploratory and conclusive results. Since this research is addressing the risk of exposure of the large-scale apparel manufacturing companies in Sri Lanka and gives insights of it with evidence, this has an exploratory research design approach. This study was conducted using two risk assessment methodologies. The conclusion of this research will help to identify the most suitable risk assessment methodology among these two along with the most accurate risk ranking. Therefore, this research has a conclusive research design approach as well.

This research has a semi-quantitative approach since the qualitative data have been collected in the form of quantitative data and quantitative risk analysis methodologies have been used to analyse them.

3.1 Population Sampling

There were around 1045 exporters who exported garment products from Sri Lanka by 2002 according to the custom reports. Around 23% of them were large scale apparel manufactures. They account for more than 90% of the garment exports in the country. There are around 300 large scale apparel manufacturing companies operating by 2013 [6]. Even among them more than 70% of the total garment exports were exported by extra-large scale apparel manufactures. But more than 50% of those total exports were made by just 4% key players in the industry [3]. Those key market players were the target population for this research since they largely impact the country's economy. This research was done using a nonprobability sampling method. The key players in the garment exports account for more than 50% of the export earnings. The purpose of this research was to identify the risk factors in the industry that can have a huge impact on the Sri Lankan economy. By identifying them and taking preventive action in advance, more than 50% of the export earnings can be saved. The most influencing key players were selected using purposive sampling.

Since it is not easy to identify all the key players in the market due to the unavailability of data and inconceivable to reach or make connections with all the key players, only a few of them were selected using convenient sampling methods. 15 such key players were assessed in this study [6]. Then the respondents within one selected company were also chosen from convenience sampling method because it is difficult to reach and collect data from some eligible respondents.

3.2 Data Collection

The data collection was planned according to the requirement of risk assessment methodologies as well. Both primary and secondary data were used for this study. The secondary data were collected using a literature survey to list down the supply chain risk factors affecting large scale apparel manufacturing companies. Both overseas and Sri Lankan studies were assessed to distinguish the factors. 30 risk factors related to the supply

chain functions in apparel manufacturing firms were identified by referring to available literature. The primary data required for this study were collected from questionnaires in two stages. The eligible population who possessed adequate knowledge and experience about the risk exposure of the companies were executive and above level employees who are well educated and had enough experience in the industry. The accuracy or the applicability of the secondary data in practical context were measured using primary data.

3.3 Data Analysis

Most of the risk assessment through literature was conducted by classifying the risk concept into two major categories. Accordingly, any business risk has two phases as probability or the likelihood of the risk occurring and the impact of it on the business or the loss that the business has to bear from the mentioned risk if the risk impacts the business performance. This simplifies and eases the decision making about the risk exposure since the availability of multiple criteria makes it too complex to make decisions whilst reducing the accuracy [9].

3.4 Risk Matrix Methodology

This semi-quantitative risk assessment methodology has been used widely in risk analysis research [15]. Risk Matrix methodology has been developed using the probability and the impact as mentioned above. The probability and the impact of the risks can be measured from Likert scales from 1 to 3/ 5/ 7 or 10. 1 to 7 Likert scale was devised as mentioned below to rate the probability of occurrence of the mentioned risks [16].

1	Very low probability
4	50% probability of occurring
7	100% probability

Likewise, 1 to 7 Likert scale was devised as mentioned below to rate the impact of the mentioned risks.

1	Minor impact
4	Few moderately negative impacts
7	Huge business loss

After assessing the probability and the impact of the mentioned risks, the overall risk was quantified as per the below mentioned equation.

$$Risk = Probability\ of\ loss \times Impact\ of\ the\ loss \dots(2)$$

Then the identified risks were ranked according to the multiplied value by arranging them in a sequence from the highest to the lowest number. The severity of each risk was grouped according to the probability and the impact. As Low as Responsibly Practicable (ALARP) principle was used to identify the high, medium and low risk regions in the risk matrix [18].

3.5 Borda Count Methodology

Borda Count methodology gives rankings by comparing each factor in pairs considering each respondent's ranking. Though this methodology has not been used widely in risk assessment research, Borda Count methodology is one of the most suitable among the ranking methods [19]. This gives the priority to the risks that have higher rates from many respondents. Neglecting the majority criterion is a disadvantage of this methodology [19].

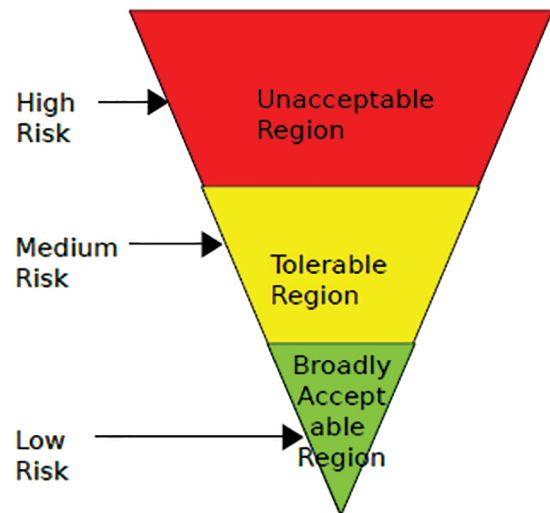


Figure 2 - ALARP Triangle

Table 1 - Matrix Categorisation

Number of Cells in Matrix	Risk Level	Tolerability
2 - 5	Low	Broadly acceptable region
6 - 8	Medium	Tolerable region
9 - 14	High	Unacceptable region

4. Research Findings

According to the outcome of the first stage survey, the mentioned 30 risk factors had the following statistical features for the questions asked about the probability of occurrence.



Table 2 - Statistical Representation – Probability and Impact of Risk Factors

Risk factor	Probability					Impact			
	Sum	Mean	Mode	Rank	SD	Sum	Mean	Mode	Rank
A- Not meeting deadlines	386	3.642	4	17	1.800	568	5.358	7	3
B- Labor turnover	456	4.302	5	5	1.581	552	5.208	6	4
C- High labor cost	450	4.245	4	6	1.420	529	4.991	5	10
D- Labor Disputes	362	3.415	4	24	1.524	484	4.566	5	23
E- Poor market Forecasting	365	3.443	2	23	1.724	529	4.991	5	10
F- Material Cost	444	4.189	4	8	1.468	543	5.123	6	5
G- Long cycle time	423	3.991	4	11	1.509	522	4.925	6	14
H- Lack of capacity	370	3.491	3	21	1.652	484	4.566	6	23
I- High transport charges	267	2.519	1	30	1.605	492	4.642	6	21
J- Product damage while transporting	381	3.594	2	18	1.620	472	4.453	4	27
K- Transport delays	369	3.481	2	22	1.742	527	4.972	6	12
L- Errors in documents	335	3.160	2	28	1.697	481	4.538	6	26
M- Time wastage in documentation	355	3.349	2	27	1.645	446	4.208	4	29
N- Cost (paper, mailing, transportation)	376	3.547	3	20	1.586	440	4.151	4	30
O- Process complexity	411	3.877	4	13	1.666	484	4.566	3	23
P- Less visibility in supply chain	389	3.670	4	16	1.608	498	4.698	5	19
Q- IT system issues	357	3.368	2	26	1.675	453	4.274	5	28
R- Poor understanding between SC partners	358	3.377	2	25	1.546	487	4.594	4	22
S- Brand name damages	292	2.755	1	29	1.871	539	5.085	7	6
T- Quality issues in outsourced services	377	3.557	3	19	1.862	535	5.047	7	8
U- Import/ Export tax	410	3.868	4	14	1.604	509	4.802	5	18
V- Unfavourable changes in trade agreements	398	3.755	4	15	1.700	516	4.868	5	16
W- Unfavourable government policies	441	4.160	4	9	1.544	532	5.019	5	9
X- Rupee value depreciation	479	4.519	6	3	1.811	513	4.840	6	17
Y- Low profit margin per product	448	4.226	4	7	1.703	520	4.906	5	15
Z- Technology changes	419	3.953	4	12	1.769	496	4.679	5	20
AA- Global competition	525	4.953	6	1	1.629	578	5.453	6	2
AB- Customer loss	467	4.406	6	4	1.901	604	5.698	7	1
AC- Volatile Demand	441	4.160	4	9	1.538	526	4.962	6	13
AD- Fast fashion changes	491	4.632	6	2	1.742	536	5.057	6	7

Impact	7	S		T	A		AB	
	6	I	KL	H	FGAC	B	XAAAD	
	5		EQ		CDPUVWY Z			
	4		JMR	NO				
	3							
	2							
	1							
		1	2	3	4	5	6	7
		Probability						

Figure 3 – Risk Matrix

4.1 Probability of the Risk Factors

The probability of each risk factor has been assessed separately in Table 2. If the probabilities were ranked according to the total rank given by every respondent, the most probable five risks are global competition, fast fashion changes, rupee value depreciation, customer loss, and labour turnover. The impact of each risk factor has been assessed separately in Table 2 as well. If the impacts were ranked according to the total rank given by every respondent, the most influencing five risks are customer loss, global competition, inability to meet deadlines, labour turnover and material cost.

4.2 Risk Matrix

The risk matrix mentioned in Figure 3 was plotted using the mode of the rankings given by all the respondents for each risk factor. According to the 7 by 7 standard risk matrix, the risks can be categorised into the unacceptable region, tolerable region and broadly acceptable region and visualise as represented in the matrix in Figure 3. As the above statistics represent, there are no broadly acceptable supply chain risks in the identified 30 risk factors. Only 11 risk factors lie under the tolerable region. All the other 19 risk factors need immediate preventive action since they lie under the unacceptable risk region.

Table 3 - Methodology Comparison

Customer loss	Customer loss
Fast fashion changes	Fast fashion changes
Labor turnover	Labor turnover
Rupee value depreciation	Material Cost
Material cost	Volatile Demand
High Labor cost	Rupee value depreciation
Unfavourable government policies	High Labor cost
Low profit margin per product	Unfavourable government policies
Volatile Demand	Low profit margin per product
Long cycle time	Long cycle time
Not meeting deadlines	Customer loss
Import/ Export tax	Not meeting deadlines
Technology changes	Import/ Export tax
Unfavourable changes in trade agreements	Unfavourable changes in trade agreements
Quality issues in outsourced services	Process complexity (More parties involved)
Process complexity (More parties involved)	Quality issues in outsourced services
Transport delays	Poor market Forecasting
Less visibility in supply chain	Less visibility in supply chain
Poor market Forecasting	Transport delays
Product damage while transporting	Product damage while transporting
Lack of capacity	Poor understanding between SC partners
Labor Disputes	Lack of capacity
Poor understanding between SC partners	Labor Disputes
Cost (paper, mailing, transportation)	Cost (paper, mailing, transportation)
IT system issues	IT system issues
Errors in documents	Time wastage in documentation
Time wastage in documentation	Errors in documents
Brand name damages	Brand name damages
High transport charges	High transport charges



Table 4 - SC Risk Ranking by Organizational Environment

Rank	Organizational Environment				
	Internal Environment		External environment		
	Process Risk	Control Risk	External to the company		External to the Supply Chain
			Demand Risk	Supply Risk	
1	Labor turnover	High labor cost	Customer loss	Material cost	Global competition
2	Labor disputes	Brand name damages	Fast fashion changes	Long cycle time	Rupee value depreciation
3	Not meeting deadlines	Low profit margin per product	Volatile Demand	Technology changes	Unfavorable government policies
4	Lack of capacity			Quality issues in outsourced services	Import/ Export tax
5	Poor market forecasting			Process complexity	Unfavorable changes in trade agreements
6	Cost in documentation			Less visibility	
7	IT system issues			Transport delays	
8	Errors in documentation			Product damage while transportation	
9				Poor understanding between SC partners	
10				Time waste in documentation	
11				High transportation charges	

4.3 Borda Count Methodology

The risk ranking given by this methodology is mentioned in the second column in Table 3.

4.4 Methodology Comparison

Comparison of the results received from the aforementioned two methodologies are presented in Table 4. According to the rankings given by Risk Matrix Methodology and Borda Count Methodology, the global competition, customer loss, fast fashion changes and labour turnover can be identified as the most critical four risks. Then the risk matrix methodology identifies the rupee value depreciation as the fifth critical risk while the other methodology presented the material cost in the fifth place.

Both the above rankings gave almost similar rankings with slight changes in some risk ranks. The correlation between two methodologies were deciphered using R statistical language as mentioned in Table 5 to generate correlation matrix. It shows that the correlation coefficient between the outcomes of Risk Matrix Methodology and the Borda Count Methodology is 0.9895467. Therefore, it can be concluded that both ranking methodologies have a very high correlation. Sum, mean and mode calculated from the rankings given by the field experts (Table 6) indicates that experts

prefer the risk ranking given by the Borda Count Methodology over the ranking given by the Risk Matrix Methodology. Hence, the most accurate and suitable risk ranking for large scale apparel manufacturing companies can be ranked as mentioned in the second column in Table 3.

Finally, the risk factors can be aligned by their severity considering the organisational environment which is mentioned in Table 4.

Table 5 - Correlation of the Methodologies

Methodology	Risk Matrix	Borda Count
Risk Matrix	1	0.9895467
Borda Count	0.9895467	1

Table 6 - Statistics

Methodology	Sum	Mean	Mode
Risk Matrix	161	7.666667	8
Borda Count	171	8.142857	9

5. Conclusions

Thirty (30) supply chain risk factors in the apparel manufacturing companies were identified under each organisational environment as not meeting deadlines, labour turnover, high labour cost, labour disputes, poor market forecasting, material cost, long



cycle time, lack of capacity, high transport charges, product damage while transporting, transport delays, errors in documents, time wastage in documentation, cost of documentation, process complexity, less visibility in supply chain, IT system issues, poor understanding between supply chain partners, brand name damages, quality issues in outsourced services, import/ export tax, unfavourable changes in trade agreements, unfavourable government policies, rupee value depreciation, low profit margin per product, technology changes, global competition, customer loss, volatile demand and fast fashion changes.

Both risk rankings were strongly correlated. But there were slight changes as well. According to both rankings, the four most critical supply chain risk factors were global competition, customer loss, fast fashion changes and labour turnover. A field expertise survey was conducted to identify the most suitable supply chain risk ranking and, according to the feedback of 21 eligible respondents who were in managerial levels with high level of experience in the field, the best risk ranking was the one received from the Borda Count Methodology. According to this study, the most accurate risk rating method is the Borda Count Methodology.

6. Recommendations

According to the outcomes of this research, many of the most crucial supply chain risks are from external business environments. The challenges from the external environments are assumed to be difficult to manage. Yet, since large scale apparel manufacturers are big entities in the industry, they can have considerable influence on the external environment as well. Therefore, the companies must exert a higher effort on managing them since it will attract more advantages than the effort put on managing them.

The risks related to employee behaviour were also in the most critical risks. Thus, the companies must focus more on employee satisfaction as well since retaining the employees saves a huge cost for the company. Improving their welfare facilities will be a good way to retain employees. Further, there must be a platform to assess and identify their problems individually to give them solutions, so that those employees can continue to work after overcoming the mentioned problems.

Further, the problems related to supply chain partner integration can be considered a high-risk area as well. A better integration platform must be designed eliminating the communication gaps between them. Furthermore, the complexity of the network must be minimized.

According to the classification of the risk matrix, there is no negligible risk in all the 30 identified supply chain risk factors. Hence, the large-scale apparel manufacturing companies should not take all the mentioned risks lightly. All of them must be taken into consideration and solutions should be generated for each of them.

7. Implications

The findings of this study can be applied in future risk assessment studies as well. Since this research states the most critical supply chain risk factors for the large-scale apparel manufactures in Sri Lanka, future researchers can apply them if they need to identify the riskiest supply chain operations for further studies. Since this study shows the ranking of the most probable risks and most impacting risks, they also can be used in relevant studies. The biggest advantage of this study is for the large-scale apparel industry since they can identify the most crucial supply chain risks, most probable risks and most impacting risks by this study. Therefore, the decision-makers in the relevant cluster of companies can identify the risks they need to focus more to manage them. Thus, those companies can avoid and mitigate the impact of them or overcome those challenges to be successful in the industry.

This study identified only the supply chain risks for extra large scale apparel manufacturers in Sri Lanka. Similar studies can be done to identify the risk factors in other operational areas and for small and medium scale apparel manufacturers in Sri Lanka. Since the Borda Count Methodology was identified as the best ranking methodology in this study, it can be used in future studies as well for the risk assessments. Further, such risk ranking studies can be done for the other industries as well.



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