Evaluation of Critical Factors of Production System Life Cycle (PSLC): An AHP Approach

Aditya Singh[1], Praveen Patidar[2], Anshu Kumar[3]

[1]*Research Scholar, Vikrant Institute of Technology & Management Indore (M.P), India*
[2]*Asst. Professor, Vikrant Institute of Technology & Management Indore (M.P), India*
[3]*Asst. Professor, Dept. of Mechanical Engineering, SVVV Indore (M.P), India*

Abstract - *Now days there are wide variety of products in markets to the customers at economical rates. Wide variety of products has condensed the life cycle of production system in the current competitive scenario. Therefore, today, an effective and dynamic production system is essential for the growth of manufacturing industry. Apart from this, manufacturers have to face the problem of choosing the right manufacturing strategy at various stages of production system life cycle (PSLC). In this context, various critical factors in various stages of PSLC were identified according to a systematic approach. Consequently, in the review of literature and expert opinion several important factors were identified for various levels of PSLC. After this, we preferred the important PSLC critical sub-factors using the analytical hierarchical process (AHP) method and evaluated the effect on the PSLC decision.*

***Key Words*: Production system life cycle, Product life cycle, Production system, Decision making, MCDM, AHP**

1. INTRODUCTION

Manufacturing is the backbone of the industrialized nation. The main objective of a manufacturing industry is to produce a quality product and make profitable organization. To achieve these goals, the organization needs to transform certain inputs such as people, equipment, money, information and energy into specific outputs such as finished products in the required quantity and with good quality. The conversion of inputs into desired results is achieved through the production process. The production process manages the conversion of resources into products. In the production process, value creation takes place at every step. The production process plays a crucial role in creating a competitive environment for an organization. The production system produces the products of an organization. The production system combines resources such as people, equipment and procedures to complement the manufacturing operations of an organization.

1.1 Product life cycle

All products and services have certain life cycles. The life cycle refers to the period from the product's first launch into the market until its final withdrawal and it is split up in phases. Product life cycle consists of four stages namely: introduction, growth, maturity and decline which are shown in Figure 1.1.

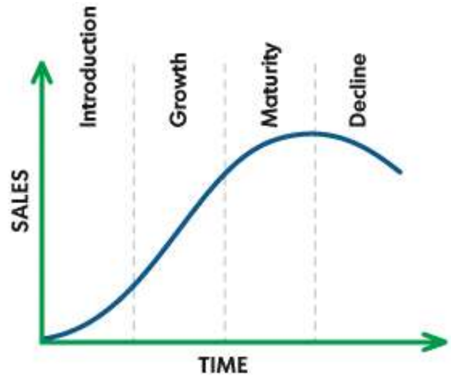

Figure 1.1: Stages of Product life cycle

Introduction: In the introduction stage of product life cycle (PLC), the product is introduced into the market.
Growth: In this stage, the product gains market acceptance, thereby, results into improved sales and profit to the organization.
Maturity: In this stage of PLC, the sales reach at its maximum level. This stage is also characterized by the slowdown of sales growth
Decline: At this stage, the sales of product go on declining. It results in the reduction of profit to the organization.

1.2 Life cycle aspect to production system

In PLC, product undergoes different stages i.e. introduction, growth, maturity, decline and death. In these stages of PLC, marketing decisions play the important role. The similar life-cycle formation is extended to the production system. In the introductory phase of PSLC, the product idea and its design are selected. Then, production facilities for the production of products are provided. These decisions are important strategic decisions that must be made by the management of the company. As a result, the production system becomes as stable as existing organizations. At this point, decisions are short-term tactical decisions and the system is influenced by internal and external environmental changes. When fundamental changes are made to the external environment, the production system has difficulty in adapting to these required changes and leads to system shutdown. This can take the form of liquidation, a sale or a merger. In some cases, the system is intentionally defined for a certain period of time. [2] [6]

1.3. Decision making in production system life cycle

In every stage of production system life cycle (PSLC), the decision makers or manufacturing managers have to take numerous decisions (generally strategic in nature) more efficiently in a specified time horizon. Table 1.1 shows the brief overview of decisions to be taken in different stages of production system life cycle.

Table 1.1: Decision to be taken in different stages of PSLC

Sr. No.	Stages	Decisions
1.	Initiation stage	• Product idea selection
2.	Design & Development stage	• Product design • Process design
3.	Operation stage	• Quality control system • Production planning system • Scheduling system • Inventory control system
4.	Revision stage	• Failure cause analysis of machine tool • Prediction of actual environmental change • Seeking for solution of environmental change
5.	Termination stage	• Decision on recover of resources

The availability of wide variety of products at economical prices has condensed the life cycle of production system in the current competitive scenario. So, effective and dynamic production systems are essential in the today's competitive atmosphere for the manufacturing organizations. Extensive literature analysis have revealed that numerous authors have applied various multi-criteria decision making (MCDM) approaches for effective decision making in some particular activities or phases like product design, process design, facility location and facility layout etc. of PSLC. But, no work is available which focuses on the identification of critical factors in different stages of production system life cycle whose consideration can upsurge the quality of decisions. So, the current dissertation is aimed at the identification and analysis of critical factors in the different stages of production system life cycle.

2. LITERATURE REVIEW

The directed literature review conducted in this section to collect recent information on the critical factors of the production system. These important factor, managers do not realize the importance of implementation of the production system and the real benefits. Nakano et al., (2008) proposed the four stages of the production system life cycle. The first stage is start up stage, in this stage Product design, Process planning, Plant (equipment) design, Layout design, Evaluation of productivity and cost, and Operation. Bellgran et al., (2002) stated the even stages of the production system life cycle. Wiktorsson, (2000) proposed the seven stages of the production system life cycle. In this model production system starts from the planning, afterwards Design, realization, start-up, operation, operation refinement and lastly termination or re-use. Kosturiak and Gregor, (1999) proposed the production system life cycle model in four stages system analysis, planning, implementation and operation. Malviya and Kant (2017) have applied fuzzy analytical hierarchy process (AHP) approach for the identification of barriers of the green supply chain. Asif, (2015) has developed an AHP based framework for determining the improvement needs in higher education. Luthra et al., (2015) have used AHP method for ranking the barriers inhibiting the adoption of renewable or sustainable technologies. In above literature, factors for each stage of production system life cycle has not been enlisted and analyzed.

3. IDENTIFICATION OF FACTORS AFFECTING PSLC DECISIONS

The various main or sub critical factors affecting the decisions in different phases of PSLC are as follows:

1. **Initiation stage (IF):** These product life quality factors govern the decisions of initiation stage of PSLC.
    1. Strategic decision making ability (IF1)
    2. Honesty & sincerity in collecting and analysing field data (IF2)
    3. Cost and Revenue analysis (IF3)
    4. Evaluation of product market (IF4)
    5. Profit and Risk analysis of product (IF5)
    6. Feasibility analysis (IF6)
    7. Use of tool or techniques for idea screening (IF7)

2. **Product design (PDF):** These product life quality factors govern the decisions of product design stage of PSLC.
    1. Customer needs and requirements (PDF1)
    2. Technical Analysis (PDF2)
    3. Proper analysis of consumer market and competitiveness (PDF3)
    4. Proper evaluation of alternative designs (PDF4)
    5. Use of relevant design software (PDF5)
    6. Comparative analysis of the product designed with the opponent's product (PDF6)
    7. Appropriate Product Testing Program (PDF7)

3. **Process design (PCDF):** These product life quality factors govern the decisions of process design stage of PSLC.
    1. Technology evaluation and Selection (PCDF1)
    2. Transformation process evaluation and selection (PCDF2)
    3. Proper assessment and selection of specific equipment (PCDF3)

4. Proper analysis and selection of production routing: Availability of workforce (PCDF4)
5. Specific equipment availability (PCDF5)
6. Supplier availability and Support (PCDF6)

4. **Quality control (QCF):** These product life quality factors govern the decisions of quality control system stage of PSLC.
    1. Quality of product design (QCF1)
    2. Organizational objectives for quality control (QCF2)
    3. Design of acceptance sampling plan (QCF3)
    4. Process control measures (QCF4)
    5. Defining location of inspection activities (QCF5)
    6. Determining frequency of inspection activities (QCF6)
    7. Application of computer software package for quality control (QCF7)

5. **Production planning (PPF):** These product life quality factors govern the decisions of production planning system stage of PSLC.
    1. Forecast of Market demand analysis (PPF1)
    2. Proper cost analysis of different combinations of resources (PPF2)
    3. Proper Data Collection (PPF3)
    4. Proper Production Planning Strategy (PP4)
    5. Proper application of production planning techniques (PPF5)

6. **Scheduling stage (SSF):** These product life quality factors govern the decisions of scheduling system stage of PSLC.
    1. Proper allocation of resources (SSF1)
    2. Accurate sequence of order performance (SSF2)
    3. Proper dispatching of orders (SSF3)
    4. Appropriate follow up of orders (SSF4)
    5. Proper utilization of scheduling tool and techniques (SSF5)
    6. Developing appropriate late-order strategies (SSF6)

7. **Inventory control stage (ICF):** These product life quality factors govern the decisions of inventory control system stage of PSLC.
    1. Accurate level of safety stock (ICF1)
    2. Accurate analysis of inventory cost (ICF2)
    3. Accurate time of order placement (ICF3)
    4. Computer software applications for inventory management (ICF4)
    5. Accurate inventory control policy (ICF5)

8. **Revision stage (RF):** These product life quality factors govern the decisions of revision stage of PSLC.
    1. Evaluation of Production Strategy (RF1)
    2. Proper Consumer Surveys (RF2)
    3. Accurate forecasting of environmental change (RF3)
    4. Cost-Effectiveness analysis of each alternative (RF4)
    5. Employee support for the implementation of the solution (RF5)
    6. Appropriate implementation plan (RF6)

9. **Termination stage (TF):** These product life quality factors govern the decisions of termination stage of PSLC.
    1. Product Lifecycle Assessment (TF1)
    2. Technical development (TF2)
    3. Production necessities (TF3)
    4. System blending (TF4)
    5. Profit analysis (TF5)
    6. Government rules and regulations (TF6)
    7. Analysis of product market pressure (TF7)
    8. Manner of system phase-out (TF8)

4. Methodology

In this research, analytic hierarchy process (AHP) method is used to prioritize the critical factor p of PSLC for successful decision taken in production system.
Analytic Hierarchy Process (AHP) approach is a mathematical technique for analysing the complex problems by assimilating various measures into a single value for prioritizing the alternative decisions through the pair wise comparison judgments. It carefully mimics the human decision making process and integrates inconsistency. It offers a comprehensive arrangement to pool one's instinctive, rational and illogical values during the decision making. In other words, it provides a structure to manage multi-criteria situations with intuitive, consistent, quantitative and qualitative characteristics.

5. DEVELOPMENT OF AHP MODEL

For effective decisions in PSLC, the AHP model was developed using the steps outlined in the above section. The details are as follows:

Step 1: Develop decision making problems and develop AHP models.

This step includes the development of AHP hierarchical models. This includes the main purpose, the main factor, the sub-factor and the result. The main objective is to give priority to the main factors and sub-factors of PSLC for effective decision making. The AHP model for decision-making problem is shown in Figure 5.1. In this hierarchical model, the goal is placed at the top, which is to say at the first level. Nine main factors, i.e. Initiation stage, product design phase, process design stage, quality control system, production planning system, scheduling system, inventory control system, revision stage and termination stage are the second level of the AHP model. The third level of the AHP model comprises 58 sub-factors for these nine main factors. There are seven sub-factors related to initiation stage, product design, process design, and quality control system, five sub-factors related to production planning system, six sub-factor related to the scheduling system, five sub-factor related to inventory control system, six sub-factor related to revision stage, eight sub-factors related to termination stage of PSLC. The main factors and their sub-factors modeled in different levels of the hierarchy model can be evaluated by using the AHP method. In this method, a pair-wise comparison of sub-factors in each level is performed with regard to each main factor. Afterward, global priority weights for each sub-factor are computed by multiplying the local weight of sub-factor with the weight of factor above them. The lowest level (fourth level) of the hierarchy model comprises of the result (viz. effective decisions in PSLC).

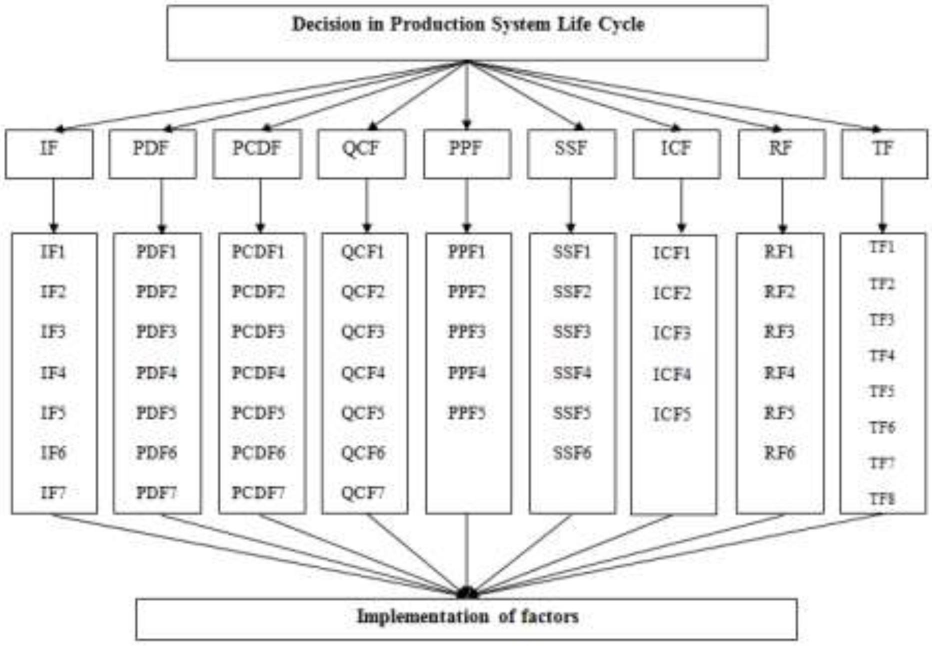

Figure 5.1. AHP model of PSLC

Step 2: Collect the data from experts

After the development of AHP hierarchical model, the next step in the AHP method is to measure and collect data. This includes establishing pair comparison of main factors and sub-factors with the help of industrial experts. A nine point scale (Table 5.1) is used to assign comparative values to pairs between different major factors and sub-factors. In the current work, expert for judgment from industry having experience about 15 years in design and product development.

Step 3: Compute normalized priority weights for individual main factor and sub- factor.

In this step of AHP approach, relative importance of main factor and their sub-factor is determined by pair-wise comparison matrices developed in consultation with experts. It consists of following two sub-steps.

(a). Development of pair-wise comparison matrices

In the first sub-step, pair-wise comparison matrices are developed for main factor and sub-factor. The main factor present in the higher level affect the sub-factors present below their levels. So, higher level main factors are considered to be a governing factors for the lower level sub-factors. Thus, the lower level sub-factors are compared to one another on the basis of their effect on factors. On the basis of this, square matrix of judgments is obtained.

Table 5.1: Nine point scale of preference between two factors of PSLC

Level of importance	Definition	Descriptions
1	Equal important	Two production system life cycle factors contribute likewise to the goal.
3	Weak important	Experience and judgment marginally support one PSLC factors over another.
5	Essential important	Experience and judgment strongly or essentially support one PSLC factors over other.
7	Demonstrated important	A PSLC factors is strongly preferred over other and its
9	Absolute important	Evidence preferring one product life cycle quality factors over other is of highest possible order of confirmation.
2,4,6,8	Intermediate values among two judgment	When comparison is required.
Reciprocals	Reciprocals for inverse comparison	A reasonable assumption.

(b). Compute the degree of consistency

It is understood that decision makers are often irregular in response to questions. Therefore, it is mandatory in the AHP approach to calculate the level of consistency of the rated vector. Saaty (1994) explained that it was possible to calculate the stability of comparison by calculating priority vectors (PV). For this, the consistency ratio is calculated.

The acceptable value of consistency ratio is 0.05 for matrix 3x3 sizes, 0.08 for matrix 4x4 sizes and 0.1 for matrices of size 5x5 or more (Saaty, 1994; 2008). The computed results will be valid only if the value of consistency ratio lies within the suitable range. The consistency ratio is determined by calculating the priority vector after the development of all pair wise comparison matrices of decision problem. The steps for calculating the priority vector are as follows:

1. Let D_1 represents the pair wise comparison matrix.
2. Compute the sum of all the respective columns of matrix D_1.
3. Then, divide each value of column of matrix D_1 by sum of its respective column. Now, all the elements of matrix D_1 will have normalized values.
4. Then, compute sum of each row of matrix D_1.
5. Afterwards, compute average of the sum of each row of matrix D_1. This value is known as priority vector.

For checking of consistency of judgments, steps discussed underneath are utilized:

1. Let D_2 represents the principal matrix. This matrix consists of priority vectors of each row of matrix D_1.
2. Then calculate $D_3= D_1 \times D_2$ and $D_4= D_3/D_2$.
3. Now, compute λ_{max} (where, λ_{max} = average of elements of matrix D_4).
4. Then calculate consistency Index $CI = \frac{\lambda \max - n}{n-1}$
5. Finally calculate CR (Consistency ratio)= $\frac{CI}{RI}$

It may be noted here that random index (RI) is to be taken from the Table 5.2 corresponding to the numbers of elements in the decision matrix. Furthermore, if consistency ratio comes to be less than 0.1, then judgement is said to be consistent. If it comes more than 0.1, then quality of judgement has to be improved. Pair wise comparison matrix of all PSLC sub-factors represented in table 5.3 to 5.12.

Table 5.2: Average random index values

No. of elements in Matrix (n)	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.41	1.45	1.49

Source: Saaty (1994)

Table 5.3: Pair wise comparison matrix: IF factor

	IF1	IF2	IF3	IF4	IF5	IF6	IF7	PV
IF1	1	3	3	1/3	2	3	5	0.219
IF2	1/3	1	1/2	1/3	2	2	5	0.106
IF3	1/3	2	1	1/2	3	3	5	0.167
IF4	3	3	2	1	5	5	5	0.349
IF5	1/2	1/2	1/3	1/5	1	1/3	2	0.052
IF6	1/3	1/2	1/3	1/5	3	1	5	0.078
IF7	1/5	1/5	1/5	1/5	1/2	1/5	1	0.030
Total	5.70	10.20	7.37	2.77	16.50	14.53	28.00	
λmax = 7.615	**CI = 0.1025**		**RI = 1.45**			**CR = 0.0776**		

Table 5.4: Pair wise comparison matrix: PDF factor

	PDF1	PDF2	PDF3	PDF4	PDF5	PDF6	PDF7	PV
PDF1	1	2	2	2	1/2	3	3	0.201
PDF2	1/2	1	2	2	1/2	3	3	0.166
PDF3	1/2	1/2	1	2	1/2	3	3	0.138
PDF4	1/2	1/2	1/2	1	1/2	3	3	0.114
PDF5	2	2	2	2	1	3	3	0.248
PDF6	1/3	1/3	1/3	1/3	1/3	1	1/5	0.049
PDF7	1/3	1/3	1/3	1/3	1/3	5	1	0.083
Total	5.17	6.67	8.17	9.67	3.67	21.00	16.20	
λmax = 7.613	**CI = 0.1021**		**RI = 1.35**			**CR = 0.0773**		

Table 5.5: Pair wise comparison matrix: PCDF factor

	PCDF1	PCDF2	PCDF3	PCDF4	PCDF5	PCDF6	PCDF7	PV
PCDF1	1	3	3	1/2	3	3	5	0.239
PCDF2	1/3	1	1/2	1/3	3	2	5	0.121
PCDF3	1/3	2	1	1/2	3	3	5	0.165
PCDF4	2	3	2	1	5	3	5	0.289
PCDF5	1/3	1/3	1/3	1/5	1	1/3	2	0.053
PCDF6	1/3	1/2	1/3	1/3	3	1	5	0.100
PCDF7	1/5	1/5	1/5	1/5	1/2	1/5	1	0.034
Total	4.53	10.03	7.37	3.07	18.50	12.53	28.00	
λmax = 7.4606	**CI = 0.07676**		**RI = 1.35**			**CR = 0.0581**		

Table 5.6: Pair wise comparison matrix: QCF factor

	QCF1	QCF2	QCF3	QCF4	QCF5	QCF6	QCF7	PV
QCF1	1	1/3	1/3	5	5	3	3	0.186
QCF2	3	1	3	5	5	5	3	0.341
QCF3	3	1/3	1	3	3	3	3	0.206
QCF4	1/5	1/5	1/3	1	2	2	1/2	0.069
QCF5	1/5	1/5	1/3	1/2	1	2	1/2	0.057
QCF6	1/3	1/5	1/3	1/2	1/2	1	1/2	0.047
QCF7	1/3	1/3	1/3	2	2	2	1	0.093
Total	8.07	2.60	5.67	17.00	18.50	18.00	11.50	
λmax = 7.5432	**CI = 0.0.0905**		**RI = 1.35**			**CR = 0.0685**		

Table 5.7: Pair wise comparison matrix: PPF factor

	PPF1	PPF2	PPF3	PPF4	PPF5	PV
PPF1	1	2	1	3	3	0.318
PPF2	1/2	1	2	1	3	0.230
PPF3	1	1/2	1	2	2	0.212
PPF4	1/3	1	1/2	1	3	0.160
PPF5	1/3	1/3	1/2	1/3	1	0.081
Total	3.17	4.83	5.00	7.33	12.00	
λmax = 5.298		**CI = 0.0745**	**RI = 1.12**		**CR = 0.0665**	

Table 5.8: Pair wise comparison matrix: SSF factor

	SSF1	SSF2	SSF3	SSF4	SSF5	SSF6	PV
SSF1	1	2	2	2	2	1/3	0.195
SSF2	1/2	1	2	2	1/2	1/3	0.124
SSF3	1/2	1/2	1	2	1/2	1/3	0.099
SSF4	1/2	1/2	1/2	1	1/2	1/3	0.077
SSF5	1/2	2	2	2	1	1/2	0.166
SSF6	3	3	3	3	2	1	0.338
Total	6.00	9.00	10.50	12.00	6.50	2.83	
λmax = 6.26		**CI = 0.052**		**RI = 1.24**		**CR = 0.042**	

Table 5.9: Pair wise comparison matrix: ICF factor

	ICF1	ICF2	ICF3	ICF4	ICF5	PV
ICF1	1	1/2	1/2	1/2	1/3	0.108
ICF2	2	1	2	2	3	0.330
ICF3	2	1/2	1	1/2	1/3	0.148
ICF4	2	1/2	2	1	2	0.220
ICF5	3	1/3	3	1/2	1	0.196
Total	10.00	2.83	8.50	4.50	6.67	
λmax = 5.431		**CI = 0.1077**	**RI = 1.12**		**CR = 0.096**	

Table 5.10: Pair wise comparison matrix: RF factor

	RF1	RF2	RF3	RF4	RF5	RF6	PV
RF1	1	3	3	2	5	3	0.335
RF2	1/3	1	1/3	1/3	1/5	1/3	0.056
RF3	1/3	3	1	3	3	3	0.231
RF4	1/2	3	1/3	1	2	3	0.163
RF5	1/5	5	1/3	1/2	1	1/3	0.098
RF6	1/3	3	1/3	1/3	3	1	0.117
Total	2.70	18.00	5.33	7.17	14.20	10.67	
λmax = 6.564		**CI = 0.1128**		**RI = 1.24**		**CR = 0.0909**	

Table 5.11: Pair wise comparison matrix: TF factor

	TF1	TF2	TF3	TF4	TF5	TF6	TF7	TF8	PV
TF1	1	2	2	2	2	5	3	3	0.230
TF2	1/2	1	1/2	2	2	3	3	3	0.151
TF3	1/2	2	1	3	3	3	3	3	0.203
TF4	1/2	1/2	1/3	1	2	3	3	3	0.125
TF5	1/2	1/2	1/3	1/2	1	5	1/3	3	0.094
TF6	1/5	1/3	1/3	1/3	1/5	1	1/5	1/3	0.035
TF7	1/3	1/3	1/3	1/3	3	5	1	3	0.108
TF8	1/3	1/3	1/3	1/3	1/3	3	1/3	1	0.055
Total	3.87	7.00	5.17	9.50	13.53	28.00	13.87	19.33	
λmax = 8.8766		**CI = 0.1252**			**RI = 1.41**		**CR = 0.0888**		

Step 4: Determine solution to problem

The last step in the AHP methodology is to determine the solution of problem i.e. prioritization of factors for having effective decisions in PSLC. In this step, local priority weights of all factors and their sub-factors are pooled together to find the global priority weight of entire sub-factors. The results of the pair-wise comparison matrix are presented in Table 5.13.

Table 5.12: Pair wise comparison matrix: Main factor

	IF	PDF	PCDF	QCF	PPF	SSF	ICF	RF	TF	PV
IF	1	1/3	1/2	1/2	1/2	1/2	1/2	1/3	1/2	0.048
PDF	3	1	2	3	3	3	3	3	3	0.230
PCDF	2	1/2	1	2	3	3	3	3	3	0.177
QCF	2	1/3	1/2	1	3	3	3	2	2	0.135
PPF	2	1/3	1/3	1/3	1	3	3	3	2	0.113
SSF	2	1/3	1/3	1/3	1/3	1	1/3	1/3	1/2	0.048
ICF	2	1/3	1/3	1/3	1/3	3	1	1/3	1/2	0.063
RF	3	1/3	1/3	1/2	1/3	3	3	1	5	0.117
TF	2	1/3	1/3	1/2	1/2	2	2	1/5	1	0.069
Total	19.000	3.833	5.667	8.500	12.000	21.500	18.833	13.200	17.500	
λmax = 10.088			**CI = 0.136**			**RI = 1.45**		**CR = 0.0937**		

Table 5.13: Global weightage of main factor and their sub factor

Sr. No.	PSLC factors	Criteria weight	Sr. No.	Sub factors	Local weight	Global weight
1	***Initiation stage of production system life cycle***	**0.0480**	1	Strategic decision making ability	0.2187	0.0105
			2	Honesty & sincerity in collecting and analysing field data	0.1059	0.0051
			3	Cost and Revenue analysis	0.1665	0.0080
			4	Evaluation of product market	0.3492	0.0168
			5	Profit and Risk analysis of product	0.0515	0.0025
			6	Feasibility analysis	0.0778	0.0037
			7	Use of tool or techniques for idea screening	0.0303	0.0015
2	***Product design stage of production system life cycle***	**0.2302**	1	Customer needs and requirements	0.2013	0.0463
			2	Technical Analysis	0.1661	0.0382
			3	Proper analysis of consumer market and competitiveness	0.1379	0.0317
			4	Proper evaluation of alternative designs	0.1144	0.0263
			5	Application of relevant design software's	0.2484	0.0572
			6	Comparative analysis of designed product with competitor's product	0.0486	0.0112
			7	Proper product testing program	0.0829	0.0191
3	***Process design stage of production system life cycle***	**0.1772**	1	Technology evaluation & selection	0.2386	0.0423
			2	Transformation processes evaluation and selection	0.1214	0.0215
			3	Proper assessment and selection of specific equipment	0.1645	0.0292
			4	Proper analysis and selection of production routings	0.2894	0.0513
			5	Workforce availability	0.0528	0.0093
			6	Specific equipment availability	0.0997	0.0177
			7	Supplier availability and assistance	0.0336	0.0060
4	***Quality control system stage of production system life cycle***	**0.1347**	1	Quality of product design	0.1861	0.0251
			2	Organizational objectives for quality control	0.3412	0.0460
			3	Design of acceptance sampling plans	0.2061	0.0278
			4	Process control measures	0.0689	0.0093
			5	Defining location of inspection activities	0.0569	0.0077
			6	Determining frequency of inspection activities	0.0475	0.0064
			7	Application of computer based software packages for quality control	0.0932	0.0125
5	***Production planning system stage of production system life cycle***	**0.1127**	1	Forecast of market demand analysis	0.3178	0.0358
			2	Proper cost analysis of different resources combinations	0.2302	0.0259
			3	Proper collection of data	0.2117	0.0239
			4	Proper production planning strategy	0.1597	0.0180
			5	Proper application of production planning techniques	0.0806	0.0091
6	***Scheduling system stage of production system life cycle***	**0.0485**	1	Proper allocation of resources	0.1953	0.0095
			2	Accurate sequence of order performance	0.1244	0.0060
			3	Proper dispatching of orders	0.0993	0.0048
			4	Proper follow-up of orders	0.0774	0.0038
			5	Proper utilization of scheduling tool and techniques	0.1655	0.0080
			6	Development of proper strategy for late orders	0.3383	0.0164
7	***Inventory control system stage of production system life cycle***	**0.0627**	1	Accurate level of safety stock	0.1076	0.0067
			2	Accurate inventory cost analysis	0.3295	0.0207
			3	Accurate timing of order placement	0.1476	0.0093
			4	Application of computer based software's for inventory management	0.2198	0.0138
			5	Accurate inventory control policy	0.1958	0.0123
8	***Revision stage of***	**0.1167**	1	Evaluation of production strategy	0.3354	0.0391

	production system life cycle		2	Proper consumer survey	0.0556	0.0065
			3	Accurate prediction of environmental change	0.2314	0.0270
			4	Cost-effectiveness analysis of each alternative	0.1626	0.0190
			5	Support from workforce regarding solution implementation	0.0976	0.0114
			6	Proper implementation plan	0.1174	0.0137
9	***Termination stage of production life cycle***	**0.0692**	1	Evaluation of product life cycle	0.2299	0.0159
			2	Technological development	0.1507	0.0104
			3	Production necessities	0.2031	0.0141
			4	System blending	0.1246	0.0086
			5	Profit analysis	0.0937	0.0065
			6	Analysis of government rules and regulations	0.0351	0.0024
			7	Product market pressure analysis	0.1076	0.0074
			8	Manner of system phase-out	0.0551	0.0038

6. CONCLUSIONS

After the synthesis of AHP pair comparison of each decision matrix in table 5.13, local and final weight is obtained. Ranking the total weight in descending order gives the final ranking of 58 important factors. To understand the weight of main factors, the main factors ranking is presented in Figure 6.1.

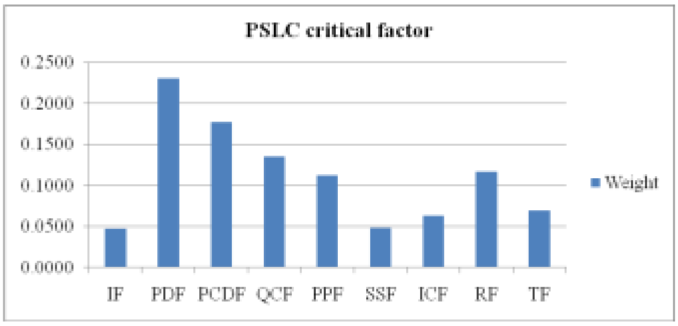

Figure 6.1: Bar Graph of PSLC facotrs

Product design stage (PDF) factor (0.2302) is observed to be the most imperative strategic area followed by process design stage (PCDF) factor (0.1772), quality control system (QCF) (0.1347), revision stage (RF) factor (0.1167), production planning (PPF) system (0.1127), termination stage (TF) factor (0.0692), inventory control (ICF) system (0.0627), scheduling (SSF) system (0.0485), and initiation stage factor (0.0480). So, it is revealed that product design occupy the top most ranking among all the considered factor i.e. process design stage, quality control system, revision stage, production planning system, termination, , inventory control system, scheduling system and initiation stage. These findings indicate that top management of the organization has to improve the product design related decisions in order to gain the long-term benefits in the current cut-throat competitive environment.

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