Chapter No. 4

Analysis and Interpretation of Data

4.1 Introduction

4.2 Analysis of Data Collected from Strategic Business Unit Head or Owner of Organization

4.3 Analysis of Data Collected from Human Resource Management, Engineering or Production Department Head

4.4 Hypotheses Testing

CHAPTER NO. 4

ANALYSIS AND INTERPRETATION OF DATA

4.1 INTRODUCTION

This chapter contains analysis and interpretation of the data. The primary data collected by taking interviews through schedules from engineering or strategic business unit, human resource and production head is analyzed by statistical tools. The methods used for presentation of primary data are tabulation and classification. Statistical methods used for analysis of primary data are measures of central tendency, percentage, coefficient of co-relation by using Likert scale etc. Hypotheses are tested by using z- test and chi-square test.

Data analysis is made in three parts-

Part I- deals with analysis of competency mapping data collected from strategic business unit head or owner of organization.

Part II- deals with analysis of data collected from human resource management, engineering or production department head.

Part III- consists of hypotheses testing.

PART I

4.2 ANALYSIS OF PRIMARY DATA COLLECTED FROM STRATEGIC BUSINESS UNIT HEAD OR OWNER OF ORGANIZATION

TABLE No. 4.2.1

Classification of sample organizations according to workforce strength:

Sr. No.	Work force strength	Total No. of organizations (Frequency)	Percentage (%)
1.	Less than 50	19	52.78
2.	50 to 200	09	25
3.	More than 200	08	22.22
Total		36	100

Source: Primary data

From the table no. 4.2.1 it is observed that 52.78 % of the organizations have less than 50 number of workforce strength. 25 % of the organizations have 50 to 200 workforce strength and 22.22 % of the organizations have more than 200 workforce strength. Majority, i.e. 52.78 % and 25 % of the engineering organizations are small and medium scale organizations respectively.

TABLE No. 4.2.2

Percentage of organizations using competency mapping:

Sr. No.	Workforce strength	Total No. of organizations	Organization using competency mapping	
			Yes	No
1.	Less than 50	19	01 (5.26 %)	18 (94.74 %)
2.	50-200	09	02 (22.22 %)	07 (77.78 %)
2.	More than 200	08	07 (87.50 %)	01 (12.50 %)
Total		36	10 (27.78 %)	26 (72.22 %)

Source: Primary data

From the table no. 4.2.2 it is observed that 5.26 % organizations of workforce strength, less than 50 have competency mapping system. 22.22 % organizations of workforce strength, 50 to 200 are using competency mapping and 87.50 % organizations of workforce strength, more than 200 are using competency mapping system. From the total sample 27.78 % of the organizations are using competency mapping.

94.74 % organizations of workforce strength, less than 50 and 77.78 % organizations of workforce strength, 50 to 200 are not using competency mapping system.

TABLE No. 4.2.3

Classification of competency mapping organizations according to using period (In years):

Sr. No.	Period from which competency mapping is used	Total No. of organizations (Frequency)	Percentage (%)
1.	0 to 1 year (Initiator)	06	60
2.	2 to 5 years	0	00
3.	More than 5 years	04	40
Total		10	100

Source: Primary data

From the table no. 4.2.3 it is observed that 60 % of organizations are initiator in the competency mapping implementation and shows 0 to 1 year of using period. 40 % of organizations are using competency mapping from more than 5 years.

This indicates that majority i.e. 60 % of the organizations are at primary stage or initiator in competency mapping.

TABLE No. 4.2.4

Classification of organizations according to in-house and outsourced competency mapping:

Sr. No.	Particulars	Total No. of organizations (Frequency)	Percentage (%)
1.	In-house competency mapping	07	70
2.	Outsourced competency mapping	03	30
Total		10	100

Source: Primary data

The above table no. 4.2.4 shows that, 30% of organizations use outsourced competency mapping model and majority i.e. 70 % of the organizations use in-house competency mapping system.

TABLE No. 4.2. 5

Classification of organizations according to organizational levels involved in competency mapping implementation:

Sr. No.	Particulars	Total No. of organizations (Frequency)	Percentage (%)
1.	From top to lower level	04	40
2.	Only for lower level (Skill matrix)	06	60
Total		10	100

Source: Primary data

From the table no. 4.2.5 it is observed that , the organizations which have competency mapping , 40 % of organizations are implementing competency mapping from top to lower level and 60 % of the organizations have used competency mapping (Skill matrix) only for lower level i.e. for workers.

TABLE No. 4.2.6

Classification of organizations with properly defined competencies of competency mapping system:

Sr. No.	Organizations with defined competencies in competency mapping	Total No. of organizations (Frequency)	Percentage (%)
1.	Yes	10	100
2.	No	00	00
Total		10	100

Source: Primary data

From the table no. 4.2.6 it is observed that organizations which use competency mapping, all organizations have defined competencies in their competency mapping system.

TABLE No. 4.2. 7

Percentage of human resource management procedures involved in competency mapping:

Sr. No.	Human resource management procedures	Total no. of organizations using competency mapping	No. of respondents (Frequency)	Percentage (%)
1.	Competency based recruitment	10	01	10
2.	Competency based training and development	10	07	70
3.	Competency based performance appraisal	10	10	100
4.	Competency based payment or bonus	10	01	10
5.	Competency based other procedure as audit	10	01	10

Source: Primary data

The above table no. 4.2.7 shows that, organizations which are using competency mapping in that, only 10 % of organizations' competency mapping include recruitment and payment or bonus human resource management procedures. 100 % of engineering units considered performance appraisal and 70 % units considered training and development, as human resource management procedures for competency mapping.

90 % of organizations are not involving other procedures of human resource management i.e. competency based recruitment, competency based payment or bonus, audit etc. as an integrated organizational competency mapping.

PART II

4.3 ANALYSIS OF DATA COLLECTED FROM HUMAN RESOURCE MANAGEMENT, ENGINEERING OR PRODUCTION DEPARTMENT HEAD.

Introduction-

The analysis tool used for data collected from human resource management, engineering or production head is Spearman's rank co- relation coefficient to assess the association between expected and observed ranks.

Key result areas of production engineers' job and basic competencies required for production engineers according to its types are analyzed with this statistical tool.

Spearman's rank co-relation *(R)* is as below-

$$R = 1 - \frac{6[\sum d^2 + \frac{1}{12}(m_1^3 - m_1) + \frac{1}{12}(m_2^3 - m_2) + \ldots]}{N^3 - N}$$

Where, d is the differences between observed and expected ranks.

m_1 is number of times first tie is repeated, m_2 is number of times second tie is repeated, and so on. N is the total number of pairs of observations.

TABLE No. 4.3.1

Key result areas of production engineers' job:

Sr. No.	Key Result Areas (KRA)	Weight (By weighted average method)	Observed Rank	Expected Rank
1.	Quality	05	1	1
2.	Process efficiency	04	2	2
3.	Product realization	03	3	3
4.	Customer focus	2.5	4	4
5.	Control plan	02	5	5
6.	Cost maintaining	02	5	6
7.	Safety knowledge	02	5	7
8.	Motivation	02	5	8
9.	Time management	02	5	9
10.	Resource management	01	6	10
11.	TPM (Total productivity Maintenance)	01	6	11
12.	Housekeeping	01	6	12
Spearman's rank co-relation coefficient $R = 0.59 \approx 0.6$				

Source: Primary data

The above table no. 4.3.1 indicates list of key result areas of production engineer's job, according to engineering, human resource management and production department head.

According to these people, quality and process efficiency are most important as they rank 1st and 2nd respectively .Whereas product realization and customer focus are tolerable as they rank between 3 to 4 and knowledge of control plan. cost maintaining. safety, motivation, time management, resource management. TPM and house keeping are supplementary as they rank between 5 to 6.

The value of Spearman's rank co-relation coefficient (R) is 0.59 which is approximately equal to 0.6. Hence, there is high degree positive co-relation between expected and observed weights.

TABLE No. 4.3.2

Classification of organizations according to competency mapping procedure with rating scales:

Sr. No.	Organizations where rating scales are used for competency mapping	Total No. of organizations (Frequency)	Percentage (%)
1.	Yes	10	100
2.	No	00	00
Total		10	100

Source: Primary data

From the table no. 4.3.2 it is observed that the organizations which are using competency mapping, in that 100 % of organizations are using rating scale for competency mapping.

This indicates that all organizations use rating scales for competency mapping.

TABLE No. 4.3.3

Classification of required engineering competencies according to competency types. i.e. Generic, Managerial, Functional, Human and Conceptual competencies.

Generic competencies required for production engineers:

Sr. No.	Generic competencies	Weight (By weighted average method)	Observed Rank	Expected Rank
1.	Basic engineering education	13	1	1
2.	Communication	12	2	2
3.	Time management	07	3	3
4.	Analysis and reasoning	05	4	4
5.	Physical ability	4.5	5	5
6.	Learning	03	6	6
7.	Listening	03	6	7
8.	Decision making	03	6	8
9.	Taking initiative	03	6	9
10.	Grasping	02	07	10
11.	Enthusiasm	02	07	11
12.	Observation	01	08	12
13.	Discipline	01	08	13
14.	Presentation skill	0.5	09	14
Spearman's rank co-relation coefficient $R = 0.76 \approx 0.8$				

Source: Primary data

The above table no. 4.3.3 indicates classification of the competencies according to the type of competencies i.e. generic competencies required for production engineers.

In the generic competencies basic engineering education, knowledge of communication and time management are considered as must as they rank from 1 to 3. Analyzing and reasoning, physical ability, learning, listening, decision making and taking initiative are tolerable as they rank from 4 to 6 and grasping, enthusiasm,

observation, discipline and presentation skill are supplementary as they rank from 7 to 9.

The value of Spearman's rank co-relation coefficient (R) is $0.76 \approx 0.8$. Hence, there is high degree positive co-relation between expected and observed weights.

TABLE No. 4.3.4

Managerial competencies required for production engineers:

Sr. No.	Managerial competencies	Weight (By weighted average method)	Observed Rank	Expected Rank
1.	Manpower managing	10	1	1
2.	Leadership	8.83	2	2
3.	Administration	8.5	3	3
4.	Planning	8.33	4	4
5.	Training others	2.5	5	5
6.	Negotiation skill	1.5	6	6
7.	Report writing	01	7	7
8.	Delegation of authority	01	7	8
9.	Taking preventive actions	01	7	9
10.	Organizing	0.5	8	10
11.	Supervising and controlling	0.5	8	11
12.	Co- ordination skill	0.5	8	12
13.	Follow up and feed back	0.5	8	13
Spearman's rank co-relation coefficient R = 0.82				

Source: Primary data

The above table no. 4.3.4 indicates managerial competencies required for production engineers. In the managerial competencies manpower management, leadership and administration are considered as must as they rank from 1 to 3. Planning, training and negotiation skill are tolerable as they rank from 4 to 6 and report writing, delegation

of authority, taking preventive actions, organizing, supervising and controlling, co-ordination, follow up and feed back are considered as supplementary as they rank from 7 to 8 .

The value of Spearman's rank co-relation coefficient (R) is 0.82. Hence, there is high degree positive co-relation between expected and observed weights.

TABLE No. 4.3. 5

Technical competencies required for production engineers:

Sr. No.	Technical competencies	Weight (By weighted average method)	Observed Rank	Expected Rank
1.	Machine and maintenance	12.5	1	1
2.	Knowledge of production process	11.5	2	2
3.	ISO system or TS (Technical specification)	08	3	3
4.	Drawing or Designing	6.5	4	4
5.	Market or business knowledge	06	5	5
6.	Knowledge of Product	5.5	6	6
7.	Basic computer, CAD (Computer-aided design), CAM (Computer-aided manufacturing)	5.5	6	7
8.	Knowledge of material or resources	05	7	8
9.	Safety	04	8	9
10.	Knowledge of quality	04	8	10
11.	Tooling	3.5	9	11
12.	Customer requirement handling	3.5	9	12
13.	Industrial engineering	3.5	9	13
14.	CNC (Computer Numerical Control) programming	03	10	14
15.	Knowledge of waste elimination	02	11	15
16.	Housekeeping	02	11	16

17.	Inspection and testing	1.5	12	17
18.	Knowledge of calibration process	1.5	12	18
19.	SPC (Statistical Process control)	01	13	19
20.	MSA (Measurement Systems Analysis)	01	13	20
21.	PPAP (Production Part Approval Process)	01	13	21
22.	Time and motion study	01	13	22
23.	FMEA(Failure Mode and Effects Analysis)	0.83	14	23
24.	APQP (Advanced Product Quality Planning)	0.5	15	24
25.	Plant layout and facility evaluation	0.5	15	25
26.	CAPA(Corrective And Preventive Action)	0.5	15	26
27.	New gauge and gig fixing	0.5	15	27
Spearman's rank co-relation coefficient R = 0.72				

Source: Primary data

The above table no. 4.3.5 indicates the technical competencies required for the production engineer's job. In the technical competencies, knowledge of machine and maintenance, production process, ISO or TS system, designing and business knowledge are considered as must as they rank form 1 to 5.

Knowledge of product, basic computer knowledge, CAD, CAM, material, safety, quality, tooling, customer requirement handling, industrial engineering knowledge and CNC programming are considered as tolerable technical competencies as they rank from 6 to 10 and west elimination, housekeeping, inspection, testing, calibration process, SPC, MSA, PPAP, time and motion study, FMEA, APQP, CAPA, plant layout facility evaluation, new gauge and gig fixing competencies are considered supplementary as they rank from 11 to 15.

The value of Spearman's rank co-relation coefficient (R) is 0.72. Hence, there is high degree positive co-relation between expected and observed weights.

TABLE No. 4.3. 6

Human competencies required for production engineers:

Sr. No.	Human competencies	Weight (By weighted average method)	Observed Rank	Expected Rank
1.	Positive attitude	4.5	1	1
2.	Hardworking	04	2	2
3.	Patience	04	2	3
4.	Interpersonal relationship	04	2	4
5.	Leadership	2.5	3	5
6.	Teamwork	02	4	6
7.	Motivation	02	4	7
8.	Confidence	02	4	8
9.	Responsibility handling	02	4	9
10.	Social awareness	0.5	5	10
Spearman's rank co-relation coefficient R = 0.43				

Source: Primary data

The above table no. 4.3.6 indicates list of human competencies required for the production engineer's job. In the human or behavioral competencies the most important competencies are positive attitude, hard working, patience and interpersonal relationship as they rank from 1 to 2 .Whereas leadership, team work, motivation, confidence and responsibility handling are considered as tolerable as they rank 3rd or 4th and social awareness is considered as supplementary as it ranks 5th.

The value of Spearman's rank co-relation coefficient (R) is 0.43. Hence, there is weak co-relation between expected and observed weights.

TABLE No. 4.3. 7

Conceptual competencies required for production engineers:

Sr. No.	Conceptual competencies	Weight (By weighted average method)	Rank
1.	Innovation	04	1
2.	Creativity	2.6	2

Source: primary data

The above table no. 4.3.7 depicts the conceptual competencies required for production engineers. According to head authorities, innovation is the most important conceptual competency as it ranks 1st and creativity is the next important as it ranks 2nd.

TABLE No. 4.3. 8

Production engineers' competencies required for sub - functional areas of production:

Table no. 4.3.8 (A)

Competencies required for designing-

Following table shows the competency domain required for 'Designing' sub-function of production.

Sr. No.	Competencies for Designing	Weight (By weighted average method)	Rank
1.	Drawing	2.5	1
2.	CAD (Computer –aided design)	02	2
3.	CAM (Computer –aided manufacturing)	02	2
4.	Computer operating knowledge	1.5	3
5.	Mathematics	1.5	3
6.	Creativity	1.5	3

Source: primary data

The above table no. 4.3.8 (A) shows list of production engineers competencies required for designing sub- function. For the designing, the most important competency is drawing as it ranks 1st. Knowledge of CAD and CAM are considered as tolerable as they rank 2nd .Whereas computer knowledge, mathematics and creativity are considered as supplementary as they rank 3rd.

Table no. 4.3.8 (B)

Competencies required for production and material planning-

Following table shows competencies required for 'Production and material planning' sub-function of production.

Sr. No.	Competencies for Production and material planning	Weight (By weighted average method)	Rank
1.	Production process knowledge	3.5	1
2.	Material planning	03	2
3.	Administration	03	2
4.	Time management	1.5	3
5.	Working condition knowledge	1.5	3
6.	Technical knowledge	1.5	3

Source: primary data

The above table no. 4.3.8 (B) shows list of competencies required for the production and material planning function. For this function the most important competency is knowledge of production process as it ranks 1st. Material planning and administration are considered as tolerable as they rank 2nd. Whereas time management, working condition and technical knowledge are considered as supplementary as they rank 3rd.

Table no. 4.3.8 (C)

Competencies required for Quality control, Lab and Calibration-

Following table shows competencies required for 'Quality control, Lab and Calibration' sub-function of production.

Sr. No.	Competencies for Q.C. , Lab and Calibration	Weight (By weighted average method)	Rank
1.	ISO / TS System Knowledge	04	1
2.	MSA(Measurement System Analysis)	2.5	2
3.	Analyzing skill	02	3
4.	Inspection	1.5	4
5.	Calibration process knowledge	01	5
6.	Claims handling	01	5
7.	SPC (Statistical Process control)	0.5	6
8.	PPAP (Product Part Approval Process)	0.5	6

Source: primary data

The above table no. 4.3.8 (C) shows the competencies required for the quality control, lab and calibration. For this function the knowledge of ISO or TS system and MSA are must as they rank from 1 to 2. Whereas the knowledge of analyzing and inspection are considered as tolerable as they rank 3rd and 4th respectively and knowledge of calibration process. claims handling. SPC and PPAP are considered as supplementary as they rank from 5 to 6.

Table no. 4.3.8 (D)

Competencies required for tooling-

Following table shows competencies required for 'Tooling' sub- function of production.

Sr. No.	Competencies for Tooling	Weight (By weighted average method)	Rank
1.	Machine operating and Machine process	02	1
2.	General CNC Programming knowledge	1.5	2

Source: primary data

The above table no. 4.3.8 (D) shows competencies required for the tooling function. The important competency is knowledge of machine operating and machine process as it ranks 1st and knowledge of general CNC programming is the next important as it ranks 2nd .

Table no. 4.3.8 (E)

Competencies required for purchasing-

Following table shows competencies required for 'Purchasing' sub-function of production.

Sr. No.	Competencies for Purchasing	Weight (By weighted average method)	Rank
1.	Communication	3.5	1
2.	Market knowledge	3	2
3.	Costing knowledge	2.5	3
4.	Customer requirement analysis	2	4
5.	Government rules and Taxation	2	4
6.	Negotiation skill	2	4
7.	Product and resources knowledge	1.5	5
8.	Record keeping	1	6

Source: primary data

The above table no. 4.3.8 (E) shows competencies required for the purchasing. For this function communication and market knowledge are the most important competencies as they rank 1st and 2nd respectively. Whereas the costing, customer requirement analysis, knowledge of government rules and taxation and negotiation skill are considered as tolerable as they rank from 3 to 4. Product and resource knowledge and recording are considered as supplementary as they rank 5th and 6th respectively.

Table no. 4.3.8 (F)

Competencies required for maintenance and storing-

Following table shows competencies required for 'Maintenance and storing' sub-function of production.

Sr. No.	Competencies for maintenance and storing	Weight (By weighted average method)	Rank
1.	Knowledge of Machine	2.5	1
2.	Knowledge of safety	2.5	1
3.	Housekeeping	2.5	1
4.	CAPA(Corrective Actions Preventive Actions)	1.5	2
5.	FMEA(Failure Mode Effect Analysis)	01	3

Source: primary data

The above table no. 4.3.8 (F) shows competencies required for the maintenance and storing function of production department. For this the most important competencies are knowledge of machine, safety and housekeeping as they rank 1st. Whereas the knowledge of CAPA is considered as tolerable as it ranks 2nd and knowledge of FMEA is considered as supplementary as it ranks 3rd.

TABLE No. 4.3.9

Competency domain required for production engineers according to organizational levels:

Organization Level	Sr. No.	Competencies	Weight (By weighted Avg. Method)	Rank
Senior Engineers (Top level Engineer)	1.	Decision making	3.5	1
	2.	Communication	03	2
	3.	Planning	03	2
	4.	Administration	03	2
	5.	Courage	01	3
	6.	Confidence	01	3
Middle level engineers	1.	Basic Engineering knowledge	2.5	1
	2.	ISO / TS System knowledge	02	2
	3.	Technical knowledge	02	2
	4.	Time management	02	2
	5.	Team Work	02	2
	6.	Customer requirement analysis	1.5	3
	7.	Maintenance and tooling	1	4
Lower level Engineers	1.	Supervision	03	1
	2.	Work done through people	02	2
	3.	Reporting	1.5	3
	4.	Controlling	01	4
	5.	Record keeping	0.5	5

Source: primary data

The above table no. 4.3.9 shows the competencies required for the production engineers according to organizational levels i.e. top, middle and lower level production engineers.

For the top level or senior production engineers the most important required competency is decision making as it ranks 1st and communication, planning and administration are tolerable as they rank 2nd. Courage and confidence are supplementary competencies as they rank 3rd.

For the middle level production engineers, the most required competency is basic engineering knowledge as it ranks 1st and knowledge of ISO / TS system, technical knowledge, time management and team work are tolerable as they rank 2nd. Customer requirement analysis, maintenance and tooling competencies are considered as the supplementary as they rank from 3 to 4.

For the lower level management supervision and work done through workers are the most important competency as they rank 1st and 2nd respectively , reporting and controlling are tolerable as they rank 3rd and 4th respectively. Whereas record keeping considered as supplementary as it ranks 5th.

PART III

4.4 HYPOTHESES TESTING

1. H_0 Majority of the engineering organizations are not implementing competency mapping.

Total No. of the samples =36

H_0: P = 80 % or 0.8 and

H_a: p ≠ 80 %

Hence, p = 0.80 and q = 0.20

Hence, from primary data observed sample proportion $(\hat{p})$ =26/36=0.72

For testing the hypothesis researcher has used z test of proportionate.

$$Z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}}$$

$$Z = \frac{0.72 - 0.8}{\sqrt{\frac{(0.8)(0.20)}{36}}}$$

$$|Z| = |-1.33|$$

The table value of Z at 5% level of significance is 1.96

The calculated value of | Z | is less than table value, hence null hypothesis H_0 is accepted.

Therefore, it is concluded that majority i.e. 80 % of the engineering organizations are not implementing competency mapping.

2. H_1 The organizations which use competency mapping have not rigorous competency mapping.

Total no. of organizations using competency mapping =10

Out of these 10 organizations:

Total no. of organizations using competency based recruitment = 01

Total No. of organizations using competency based training and development = 07

Total No. of organizations using competency based performance appraisal = 10

Total No. of organizations using competency based payment and bonus = 01

Table No. 4.4.2 Chi- square as a non- parametric test

Sr. No.	H.R. Procedures	Observed Frequency (O_i)	Expected Frequency (E_i)	$O_i - E_i$	$(O_i - E_i)^2$	$(O_i - E_i)^2 / E_i$
1.	Recruitment	01	10	-9	81	8.1
2.	Training and Development	07	10	-3	9	0.9
3.	Performance Appraisal	10	10	0	0	00
4.	Payment or Bonus	01	10	-9	81	8.1

(Source: Primary Data)

$$\therefore \quad \chi^2 = \sum [(O_i - E_i)^2 / E_i]$$
$$= (8.1 + 0.9 + 8.1)$$
$$= 17.1$$

The degrees of freedom = (n- 1) = 4-1 = 3

The calculated value of the χ^2 = 17.1

Table value at 5 percent level for 3 degrees of freedom is 7.815

As calculated χ^2 is greater than the table value therefore H_1 is rejected. Therefore from the sample information it is concluded that. the organizations which use competency mapping are rigorously implementing competency mapping.