Competency Mapping Of Engineers In The Engineering Industry Of Satara, Maharashtra

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ABSTRACT

This paper aims to examine the development of engineers' competency model in the engineering industry and its importance towards the present context of human capital and management functions in Engineering units in Satara, Maharashtra. 118 engineering units from the industrial area of Satara, Maharashtra were considered as a sample for the study. Stratified sampling survey was made from the small, medium and large scale engineering units in the industrial area of Satara, Maharashtra. The research was conducted during the period from June 2010-2011. The results of the research show that only 27.78 % of the engineering units were implementing the competency mapping concept and 60 % of the engineering units were at the initial stage of implementation. The paper describes a linear competency model for engineers, with a list of competencies according to their type and requirement level in a job. If engineering organizations use competency models, conduct research at the organizational level, renew the model with changing needs, include all human resource procedures, organizational levels and provide training to employees, then the engineering units will grow in talent and knowledge management.

Keywords : Competence, Competency Mapping, Competency Model, Engineering Units

INTRODUCTION

'Competencies' are measurable human capabilities that are required for effective work performance demands.[1] In this era of knowledge and technology, 'Competence Management' is an important research object in the more general area of 'Knowledge Management'. Competence Management system is often integrated with 'Learning management' systems. Competence management can play an important role in organizational and personal development, as it identifies key knowledge areas that an employee or an organization should possess in order to achieve his or its targets.

Competence and skills management have been tightly linked to the efforts of companies to create a setting for empowerment of their workforce in order to increase competitive advantage, innovation and effectiveness (Houtzagers, 1999). In addition, this is directly related to corporate efforts to influence internal knowledge and initiate consistent knowledge management initiatives (Hellstrom et al., 2000; Ley and Albert, 2003). In recent times, Competence Management as a research field has been attracting efforts to leverage personnel development (Beck, 2003), knowledge sharing (Won and Pipek, 2003) and corporate-learning efforts (Hock Meyer et al., 2003).

REVIEW OF LITERATURE

Despite a growing interest of competency among managers and human resource professionals in recent years, the modern competency movement in industrial-organizational psychology actually dates back to the mid 1950's to the early 1970's. In that regard, Flanagan's work (1954) and McClelland's studies (1973) are considered as two landmarks that originally invented the concept of Competency. A seminal article published by Flanagan based on studies of US Air Force Pilot Performance in 1954 established Critical Incidents Technique as a precursor to the key methodology, and it the way it is used in rigorous competency studies. Flanagan's critical incidents technique sixteen years later inspired David McClelland to discover and develop the term "Competency". The movement was originally pushed by dissatisfaction among researchers about the value of personality traits tests in predicting job performance. For instance, Ghiselli (1966) and Mischel (1968) found that testable personality traits have little correlations with job

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[1] Marrelli (1998). http://imu.ntua.gr/Papers/J53-IMCC-Draganidis+Mentzas-2005.pdf accessed on July 15, 2012.

performance, and consequently, research on these variables was of questionable value. McClelland (1973) conducted a research in order to identify "Competency" variables, which predict job performance and which were not biased by sex or socio- economic factors. Boyatzis wrote the first empirically-based and fully-researched book on competency model developments. Boyatzis was explicit in describing the importance of clearly-defined Competency as reflected in specific behavior and clearly defined performance outcomes when he wrote, "the important point is that specific actions cause, or lead to, the specified results. Certain characteristics or abilities of the person enable him or her to demonstrate the appropriate specific actions" (Boyatzis, 1982, p. 12).

Dreyfus (1986) introduced nomenclature for the levels of competence in 'Competency Development'. Goleman's (2002) research on the importance of "Emotional Intelligence" to an organization's success started to identify a number of emotional intelligence competencies. In particular, Goleman's work describes four categories of emotional intelligence: Self-Awareness, Self-Management, Social Awareness and Relationship Management. Zwell (2000, pp. 53-55), the author of *'Creating a Culture of Competence'* described competencies in six basic sets from the top performers: Initiative, Influence, Results Orientation, Teamwork, Service Orientation and Concern for Quality. Spencer (1993) said that a competency may be described as a combination of skill, attitudes and behavior that an individual or organization is competent at, that is, the ability to deliver or perform a set of tasks with relative ease and with a high level of predictability in terms of quality and timeliness. McClelland (1973) defined competence measurement as a tool for distinguishing superior performer from an average performer. Ernest (1989) presented competence as a statement which describes the integrated demonstration of a cluster of related skills and attitudes that are observable and measurable necessary to perform a job independently at the prescribed proficiency level. King (1997) described competency as an overt and measurable performance in terms of quality, quantity, time, cost or a combination of any of these, for which action or performance-oriented verbs are to be used in writing competency statements. Dranganidis, Mentazas (2007) identified competency as a combination of the tacit and explicit knowledge, behavior and skills that give somebody the potential for effectiveness in task performance. In a classic article published a few decades ago, Katz (1960) grouped Competencies under three areas - Generic, Managerial and Technical, which later expanded in Generic (competencies which are essential for the job regardless of function or level, e.g. listening, communication; Managerial (competencies essential for managerial responsibility, e.g. planning, supervising) ;Technical or Functional (competencies essential for specific type of function, e.g. finance) ; Human (knowledge, attitude and skill required to motivate people) and Conceptual (competencies required to visualize the invisible things, e.g. creativity, innovation) competencies. Literature review shows that no specific standards exist for assessing competency mapping. For the present research, the researchers relied on the existing literature. The present study is intended to study the concept of competency mapping, to find out the ways for competency mapping and to provide necessary means with respect to HR management.

METHODOLOGY

The research is of descriptive type, and the sample units for the study were selected by random sampling method and engineering firms were selected by using stratified sampling technique. Stratification is based on the basis of the size of the unit i.e. small, medium and large scale. There are overall 118 engineering units in the industrial area of Satara district of Maharashtra. Two structured schedules were used to collect primary data regarding Competency Mapping from the samples. The two structured schedules were administered to the strategic business unit head or the owner of an engineering unit, who was responsible for framing strategic objectives, vision and mission of the engineering unit and another schedule was administered to the concerned head of the production department, engineering head or human resource management head of the engineering unit, who actually implemented procedures with respect to their functional areas. The structures are based on different competencies required for production engineers. The responses to the items in the schedule are based on a 3- point scale as: 3- competencies which are a must to do that job ; 2- competencies which are tolerable for that job and ; 1- competencies which are considered as supplementary or additional to do that job. Primary data was collected by interview method and was analyzed by using suitable statistical tools like Measures of Central Tendency, Coefficient Of Correlation etc. Collected competencies are classified as Generic, Managerial, Technical, Human and Conceptual Competencies (Katz, 1960). It was assumed that a majority of the engineering units had not implemented competency mapping and the units which were using Competency Mapping had not been rigorous in implementing competency mapping.

ANALYSIS AND RESULTS

Hypothesis H_0 is that a majority of the engineering units in Satara are not implementing competency mapping.

$n = 36$

H_0: $P = 80\%$ or 0.8 and H_a: $p \neq 80\%$. Hence, $p = 0.80$ and $q = 0.20$

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

To test this hypothesis, according to the z test of proportionate :

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

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

The table value of Z at 5% level of significance is 1.96. The calculated value of $|Z|$ is less than the table value, hence, the null hypothesis H_0 is accepted. Therefore, it is concluded that majority i.e. 80 % of the engineering units in Satara were not implementing competency mapping.

Hypothesis H_1 is that the engineering units in Satara, which were using competency mapping have not implemented rigorous competency mapping. From the total sample, 10 units were using competency mapping and out of these, 1 unit included recruitment and bonus, 7 units included training and development and all units included performance appraisal for competency mapping. According to the chi-square non-parametric test :

$\therefore \chi^2 = \sum [(O_i - E_i)^2 / E_i]$

$= (8.1 + 0.9 + 8.1)$

$= 17.1$

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

The calculated value of $\chi^2 = 17.1$

Table value at 5 percent level of significance 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 units which were using competency mapping in Satara were rigorously implementing the same at the engineering units.

The data collected from HR Managers, Engineering or Production Head was analyzed by Spearman's Rank Correlation Coefficient to assess the association between the expected and observed ranks. Key result areas of production engineers' job and basic competencies required for production engineers according to its types are

Table 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 correlation coefficient R = 0.59 ≈ 0.6				
Source: Primary Data				

Table 2 : Generic Competencies Required For Production Engineers According To Basic Types of Competencies: i.e. Generic, Managerial, Functional, Human and Conceptual Competencies				
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 Skills	0.5	09	14
Spearman's rank correlation coefficient R = 0.76 ≈ 0.8				
Source: Primary Data				

Table 3: 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 skills	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.	Coordination skills	0.5	8	12
13.	Follow up and feedback	0.5	8	13
Spearman's rank correlation coefficient R = 0.82				
Source: Primary Data				

Table 4: 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(International Organization For Standardization) 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 processes	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 correlation coefficient R = 0.72				
Source: Primary Data				

Table 5: 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.	Maintaining Interpersonal relationships	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.	Handling Responsibility	02	4	9
10.	Social awareness	0.5	5	10
Spearman's rank correlation coefficient R = 0.43				
Source: Primary Data				

Table 6 : 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			

Table 7: Competencies Required For Engineers According To Sub-Functional Areas			
Competencies Required For Designing Sub -functional Area			
Sr. No.	**Competencies**	**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
Competencies Required For Production And Material Planning			
Sr. No.	**Competencies**	**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
Competencies Required For Quality Control, Lab And Calibration			
Sr. No.	**Competencies**	**Weight (By weighted average method)**	**Rank**
1.	ISO / TS (Technical Specification) 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
Competencies Required For Tooling			
Sr. No.	**Competencies**	**Weight (By weighted average method)**	**Rank**
1.	Machine operating and Machine processes	02	1
2.	General CNC Programming knowledge	1.5	2
Competencies Required For Purchasing			
Sr. No.	**Competencies**	**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 skills	2	4
7.	Product and resource knowledge	1.5	5
8.	Record keeping	1	6
Competencies Required For Maintenance And Storing			
Sr. No.	**Competencies**	**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			

Table 8 : Competency Domain Required For Production Engineers According To Organizational Levels

Organization Level	Sr. No.	Competencies	Weight T (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				

analyzed with Spearman's rank correlation (R), which is as follows :

$$R = 1 - \frac{6[\sum d^2 + \frac{1}{12}(m_1^3 - m_1) + \frac{1}{12}(m^3_2 - m_2) + ...]}{N^3 - N}$$

Where, d is the differences between observed and expected ranks. m_1 is the number of times the first tie is repeated, m_2 is the number of times the second tie is repeated, and so on. N is the total number of pairs of observations.

RESULTS AND IMPLICATIONS

From the population, it was found that 72.22 % of the engineering units were not implementing competency mapping and were also unaware about competency mapping. In the units which were already implementing competency mapping, 60 % of the units were at the initial stage in competency mapping implementation and the same percentage of units were using skill matrix for the lower organizational level. All organizations considered performance appraisal and 70 % of the organizations considered training and development programs in the area of competency mapping. Results obtained by Spearman's Rank Correlation show a high degree of positive correlation between expected and observed weights of Key result areas (0.6) (Table 1), Generic Competencies (0.8) (Table 2), Managerial Competencies (0.82) (Table 3) and Technical or Functional Competencies (0.72) (Table 4) required for the engineers' job. However, there is a weak correlation in expected and observed weights of Human competencies (0.43) (Table 5), as Human competencies vary with individuals. As per the research conducted on competency mapping, the researchers suggest a linear competency model which would be helpful for the organization to involve all organizational levels and human resource procedures as integrated competency mapping procedures. The Model

Table 9 : Competency Model For Engineers Consisting of Competencies According To Its Basic Types and Requirement Level

Sr. No.	Competency Type	Must (The competencies which are essential or must or basic for the job)	Tolerable (The competencies considered as supporting to the basic competencies)	Supplementary (Added competencies)
1.	Generic Competencies	Basic engineering education, Communication, Time Management Skills	Analysis and reasoning, Physical ability, Learning, Listening, Decision making, Taking initiative	Grasping, Enthusiasm, Observation, Discipline, Presentation skills
2.	Managerial Competencies	Manpower managing, Leadership, Administration	Planning, Training others, Negotiation skill	Report writing, delegation of authority, Taking preventing actions, Organizing, Controlling and supervision, Coordination skills, Follow-up and feedback
3.	Technical Competencies	Machine and maintenance, Knowledge of production process-es, ISO/TS system knowledge, Drawing or designing, Market or business knowledge	Knowledge of product, Basic computer operating knowledge, CAD ,CAM, Material resources knowledge, safety knowledge, knowledge of quality, Tooling, customer requirement handling, Industrial engineering, CNC programming	Knowledge of Waste elimination, Housekeeping, Inspection and testing, Knowledge of calibration processes , SPC, MSA,PPAP, Time & motion study, FMEA, APQP, Plant layout and facility evaluation, CAPA, knowledge of new gauge and gig fixing
4.	Human Competencies	Positive attitude, Hardworking, Patience, maintaining/developing Interpersonal relationships	Leadership, Teamwork, Motivation, Confidence, Handling Responsibility	Social awareness
5.	Conceptual Competencies	Innovation, Creativity		

Source: Primary Data

Table 10 : A Competency Domain For Production Engineers According To Major Sub- Functional Areas and Requirement Level				
Sr. No.	**Major sub- functional areas of production**	**Must** (The competencies which are essential or must or basic for the job)	**Tolerable** (The competencies considered as supporting to the basic competencies)	**Supplementary** (Added competencies)
1.	Designing	Drawing	CAD, CAM	Computer operating knowledge, Mathematics, Creativity
2.	Production and Material planning	Knowledge of production processes	Material planning, Administration	Time management, Working condition and Technical Knowledge
3.	Quality control, Lab and Calibration	System knowledge ISO/TS, MSA	Analyzing skills, Inspection	Calibration process knowledge, Claims handling, SPC,PPAP
4.	Tooling	Machine operating and Machine process, General CNC Programming Knowledge		
5.	Purchasing	Communication and Market Knowledge	Knowledge of costing, Customer requirement analysis, Government rules and taxation, Negotiation skills	Product and resource knowledge, Record keeping
6.	Maintenance and storing function	Knowledge of machines, Knowledge of Safety, Housekeeping	CAPA	FMEA
* C = (M + T+ S) Source: Primary Data				

(Refer to Tables 9 and 10) describes each type of competency according to its necessity level. For excellent performance, all engineers must have tolerable and supplementary competencies. Therefore, Competency required for excellent performance :

$$'C' = M + T + S$$

Where,
M = Competencies which are a must or essential for the job and having weight 50% ;
T = Competencies which are tolerable for the job and having weight 30% ;
S = Competencies which are supplementary for the job and having weight 20%.
If $C \geq 70\%$, then the engineers have extraordinary competencies ; if $C \geq 60\%$, then the engineers have satisfactory competencies ; if $C \geq 50\%$, then the engineers have average competencies and need training and if $C < 50\%$, then the engineers have unsatisfactory competencies and need special training.

CONCLUSION

As competency mapping is an effective tool of measuring competencies of the employees, it is important to improve and retain talent in the organization. This research shows the study of Competency Mapping procedures of engineering units in the industrial area of Satara, Maharashtra. The study identified that 72.22 % of the engineering units were not implementing competency mapping and were also unaware about competency mapping. The units which were implementing competency mapping - in those units, 60% of the units were at the initial stage in competency mapping implementation and the same percentage of units were using skill matrix for the lower organizational level. All units considered performance appraisal and 70% of the units considered training and development programs in competency mapping.
The paper has also presented a competency model for engineers. The model consists of the competency domain with its requirement level for the better performance of an engineer's job. Competencies are classified in the Generic, Managerial, Functional or Technical, Human and Conceptual competencies. The basic competencies required for the sub- functional areas or key result areas of the production are also provided with its necessity. If organizations would

conduct workshops, make employees aware of this concept, conduct research and renew the competency models with organizational needs and goals, both employees and organizations can overcome future challenges and flourish in the competitive environment. This will lead to competent employees, learning organizations and knowledge based organizational culture.

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