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Analysis of Manufacturing Competency for an Automobile Manufacturing Unit

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Abstract- Quality, cost, delivery, innovation, and responsiveness motivate most manufacturing premeditated agenda today. Latest development in industry have suggested the emergence of another route to manufacturing excellence, that is, there is an increasing focus by industry regulators and professional bodies on the need to stimulate innovation in a broad range of manufacturing competencies. Further, competencies can be described as aptitude to pertain a set of related information, skill, and ability to execute "critical work functions" in a defined work situation. The technical category encompasses competencies related to functions, processes, and roles within the business office which includes understanding and appropriately applying procedures, requirements, regulations, and policies related to specialized expertise. In this work various parameters of manufacturing competency are studied and analyzed by correlation, and response analysis of questionnaire responses.

Keywords: Manufacturing Competency, Quality, Product Concept, Production Planning & Control, Process Planning, Raw Material & Equipment

I. Introduction

Some scholars see "competence" as a combination of knowledge, skills and behavior used to improve performance; or as the state or quality of being adequately or well qualified, having the ability to perform a specific role.

For instance, management competency might include systems thinking and emotional intelligence, and skills in influence and negotiation. The ability of companies to effectively carry out competency-based human resources management (HRM) is becoming more and more crucial for their survival. A competency based HRM system captures the differing worth of individual contributors, facilitates multiple career paths and allows flexibility in reward-related decisions, which are important to address with the changing nature of organizations. The field of competency development is growing in popularity with administrative management in businesses and agencies worldwide. One important reason to collect data and build competency models is that they are powerful decision-making tools.

II. Literature Review

Manufacturing Competency is often regarded as a condition for improved competitiveness (Levinthal and March, 1993). Competencies in organizations can be broadly classified as employee level and organizational-level (Cardy and Selvarajan, 2006). The manufacturing function can be a formidable weapon to achieve competitive superiority (Dangayach and Deshmukh, 2000). By taking a disaggregated approach, the decomposed effects of core competencies on firm performance have been examined and the relative influences of all three major constituents of core competencies, marketing competencies, technological competencies and integrative competencies (Wang et.al, 2004). (Anders Drejer, 2001) formulated a framework for competence development as a research area and an area of management attention in firms. The architecture of the novel approach based on the traceability of the design activities which have its aim to assisting competency characterization through the qualitative feature of the work was presented by (Belkedi *et al.*, 2006).

(Eric Bonjour and Jean-Pierre Micaelli, 2010) stated that significant changes have been marked both in the strategic management field, with the development of competence-based management and the use of the concept of value creating network. (F. Belkadi *et al.*, 2007) stated that design, project managers are aware of both the impact of the designers' competencies on the project performance and of the requirement for a fast development of these competencies. The author presented the architecture of a novel approach based on the traceability of design activities which aims at assisting competency characterisation through qualitative features of the work situation in which this competency is activated.

(John P. Millikin *et al.*, 2010) examined how composition of individual capabilities within self-managed teams translates into greater effectiveness for multi-team systems (MTS) in which teams are embedded. (Justin Barnes

et al., 2001) stated that the truism to say that manufacturing firms need to innovate to reach and remain at the frontier of what has been termed ‘world-class’ competitiveness. (Qing Yu Zhang *et al.*, 2003) described a framework to explore the relationships among flexible competence, flexible capability and customer satisfaction. (Rajesh K. Singh *et al.*, 2010) described the status of the enterprises in India and China and examined the roles of government policies and strategy development for competitiveness. (Sajee B. Sirikrai and John C.S. Tang, 2006) proposed that the aggregate performance of many firms in a particular industry can reflect the competitiveness of that industry as a whole. (Sanjib K. Dutta, 2007) critically examined the framework of one of the leading awards of India by testing the relationship between stakeholder results and enabling practices using regression analysis, structural equation model and data envelopment analysis. The results of the study revealed that the framework is used by the organizations to enhance firm level competitiveness but not as a tool to contribute to national competitiveness. (Tim R. V. Davis, 1999) determined which core competencies have the strongest influence on improving the performance of different types of service businesses. (Wang Zhi yu *et al.*, 2006) reviewed development of quality management and competitive advantage and explored the notion of strategic status of quality as a source of sustained competitive advantage. (Yonggui Wang *et al.*, 2004) focused on the decomposition of impacts of core competencies on firm performance. (Yu-Ting Lee, 2006) indicated that the competency development and management are widely regarded as vital tools to enhance competitiveness for organizations and proposed a method based on the rough set theory to explore high-performers’ required competencies.

III. Factors

Based on the literature studied, following factors have been finalized:

- Product Concept
- Product Design & Development
- Process Planning
- Raw Material & Equipment
- Production Planning & Control
- Quality Control

IV. Analysis

A. Response Analysis

The response analysis was performed on the various sub scales of the manufacturing competency.

Table 1: Response Analysis (Mean) of the Respondents on Product Concept

S. No	FACTORS	No. of Companies Scoring Points				Total No. of Responses (N)	Total Points Scored (TPS)	Percent Points Score (PPS)
		A	B	C	D			
		1	2	3	4			
1.	Do you have a well planned & structured Concept Generation process in your organization?	6	40	44	28	118	330	70.0
2.	Whether your company policies promote innovation?	16	54	40	8	118	276	58.4
3.	Do you feel that marketing department is adequately motivated to get an idea about the new product?	20	37	57	4	118	281	59.5
4.	Whether your organization encourages the deployment of inter-departmental teams to identify and create new ideas?	30	55	31	2	118	241	51.0
5.	Is your organization flexible enough for making changes during operations and maintenance to satisfy customer needs?	23	74	12	9	118	243	51.5
6.	Whether your organization uses centralized planning structure for idea generation?	32	55	25	6	118	241	51.0
(Total Points Scored ‘TPS’ = A x 1 + B x 2 + C x 3 + D x 4)								

The response analysis results showed that the product concept based on the idea that “*well planned structured concept generation process*” in the organization was given maximum weightage which was followed by the idea based on *marketing department motivation enough to bring up new concepts* and *company policies to promote innovation*. In last almost similar extent of weightage was given in the surveyed organization regarding *developments of inter departmental relationships for new ideas*, *centralized planning structure development* and *flexibility of organization for making changes to satisfy customers*. The analysis assessed that only 23.7% of surveyed respondents reported that there was implementation of “*well planned structured concept generation process*” in the organization whereas majorly 37.3% and 33.9% reported it either in terms of reasonably well or

to some extent respectively. The product concept based on *company policies to promote innovation and marketing department motivated enough to bring up new concepts*, there implementation was also on the similar scale in the organization as reported by the respondents.

Table 2: Response Analysis (Mean) of the Respondents on Product Design and Development

S. No	FACTORS	No. of Companies Scoring Points				Total No. of Responses (N)	Total Points Scored (TPS)	Percent Points Score (PPS)
		A	B	C	D			
		1	2	3	4			
1.	Whether your organization has an effective Design Technology Program (CAD)?	25	20	37	36	118	320	67.8
2.	Whether your organization uses computerized technology for Analysis purposes?	12	78	25	3	118	255	54.0
3.	Whether the design program includes procedures like Product Life Cycle?	23	75	16	4	118	237	50.2
4.	Whether the design program includes Aesthetics and Ergonomics of the product?	25	38	48	7	118	273	57.8
5.	Does your organization use simulation and modeling for analyzing designs?	24	59	28	7	118	254	53.8
6.	Does your organization track Design & Development program costs?	8	46	51	13	118	305	64.5
7	What percentage of the designing is done with the aid of computer?	45	23	31	19	118	260	55.1
(Total Points Scored 'TPS' = A x 1 + B x 2 + C x 3 + D x 4)								

The response analysis results showed that the product design and development concept based on the idea that “*implementation of effective design technology program*” in the organization was given maximum weightage which was followed by the idea based on *tracking design and development costs and simulating and modeling for the analysis of the products*. In last almost similar extent of weightage was given in the surveyed organization regarding *inclusion of aesthetics and ergonomics in product designing and usage of product life cycles*, while least weightage was on the *usage of computerized technology for analysis*. The analysis assessed that only 30.5% of surveyed respondents reported that there was implementation of “*effective design technology program (CAD)*” in the organization whereas majorly 31.4% and 21.2% reported it either in terms of reasonably well or not at all respectively. The product design and development concept based on *usage of computerized technology for analysis, usage of product life cycles*, there implementation was also on the similar scale in the organization as reported by the respondents. It was analyzed that majorly 66.1% and 63.6% of surveyed respondents reported their implementation on the scale of up to some extent while 10.2% and 19.5% reported no implementation at all in their organizations whereas 21.2% and 13.6% of the respondents reported it to be at reasonably amount of implementations.

Table 3: Response Analysis (Mean) of the Respondents on Process Planning

S. No	FACTORS	No. of Companies Scoring Points				Total No. of Responses (N)	Total Points Scored (TPS)	Percent Points Score (PPS)
		A	B	C	D			
		1	2	3	4			
1.	Whether your organization has an effective Process Planning program?	12	45	29	32	118	317	67.2
2.	Does your organization apply Group Technology?	29	59	27	3	118	240	50.8
3.	Does your organization possess a mechanism for material and machine selection?	5	84	24	5	118	265	56.1
4.	Whether the planning software is updated & reviewed periodically in accordance with technological changes?	28	56	31	3	118	245	51.9
5.	Does your organization track Process Planning costs?	11	28	59	10	108	284	65.7
6.	Does your organization prefer integration of different departments?	24	51	43	0	118	255	54.0
7	Does your organization particularly take into account finishing and assembly of the product?	4	57	45	11	117	297	63.4
8	What percentage of the process planning is done with the aid of technology?	42	45	22	9	118	234	49.6
(Total Points Scored 'TPS' = A x 1 + B x 2 + C x 3 + D x 4)								

The response analysis results showed that the process planning concept based on the idea that “*implementation of effective design technology program*” in the organization was given maximum weightage which was followed

by the idea based on *tracking process planning costs* and *simulating and taking account of finishing and assemble of products*. In last almost similar extent of weightage was given in the surveyed organization regarding *usage of mechanism for material and machine selection* and *preferences to departments integration*, while least weightage was on the *software based for planning regularly updated and reviewed with technological advancement* and *group technology*. On the issue based on the process planning regarding *higher usage of process planning with computer aid*, it was evident that there was 35.6% of the organization using it less than 25.0% while 38.1% reported it to be in range of 25.0 – 50.0%. Also 18.6% the organization reported computer usage up to 50.0- 75.0% and least 7.6% organization was using it for more than 75.0% of the process. The analysis showed 27.1% of surveyed respondents reported that there was great implementation of “*effective process planning program*” in the organization whereas majorly 38.1% and 24.7% reported it either in terms of to some extent or reasonably well respectively. 71.2% of the organization reported to the implementation of *usage of mechanism for material and machine selection*, at some extent while 20.3% were using it at reasonable level.

Table 4: Response Analysis (Mean) of the Respondents on Raw Material and Equipment

S. No	FACTORS	No. of Companies Scoring Points				Total No. of Responses (N)	Total Points Scored (TPS)	Percent Points Score (PPS)
		A	B	C	D			
		1	2	3	4			
1.	Does your organization use ERP Software for record keeping?	18	31	35	34	118	321	68.0
2.	Whether your organization has its own Transportation?	49	28	32	9	118	237	50.2
3.	Whether your organization has enough warehouses for Inventory storage?	25	45	32	16	118	275	58.2
4.	Whether the three departments (marketing, designing and production) are synergistically involved in equipment selection decisions?	19	56	40	3	118	263	55.7
5.	Does your organization have sufficient automated equipment with appropriate process capabilities to meet market demands?	14	58	44	2	118	270	57.2
(Total Points Scored ‘TPS’ = A x 1 + B x 2 + C x 3 + D x 4)								

The response analysis results showed that the process of raw material and equipment based on the idea that “*usage of ERP software for record keeping*” was given the maximum weightage in the organizations which was followed by the thrust to the ideas based on *existences of warehouse facility for inventory storages*, *availability of sufficient automated equipment with processing capabilities equivalent to market demands* and *synergistically involvement of marketing, designing and production department in equipment selection*. The least preference was given to the issue of *existences of transportation facility*. The “*usage of ERP software of record keeping*” in the organization was on great extent by the 28.8% while 29.7% and 26.3% of the organization reported its usage at either reasonable or at some extent level respectively.

Table 5: Response Analysis (Mean) of the Respondents on Production Planning and Control

S. No	FACTORS	No. of Companies Scoring Points				Total No. of Responses (N)	Total Points Scored (TPS)	Percent Points Score (PPS)
		A	B	C	D			
		1	2	3	4			
1.	Whether your organization has Computerized Manufacturing Systems (CAM)?	18	49	41	10	118	279	59.1
2.	How much do you exert to get precise and accurate dimensions?	7	36	68	7	118	311	65.9
3.	Does your organization prefer GREEN MANUFACTURING?	32	55	20	11	118	246	52.1
4.	Does your organization track Production Planning & Control program costs?	13	52	42	11	118	287	60.8
5.	What percentage of the work is done with the help of robots?	91	25	0	2	118	149	31.5
6.	What is the percentage of maintenance hours in relation to total working hours?	90	27	1	0	118	147	31.1
7.	To what Extent Hydraulic and Pneumatic systems are employed in your organization?	40	51	14	13	118	236	50.0
(Total Points Scored ‘TPS’ = A x 1 + B x 2 + C x 3 + D x 4)								

The response analysis results showed that the process of production planning and control based on the idea that “*exertion on accurate and precise results*” was given the maximum weightage in the organizations which was followed by the thrust to the ideas based on *tracking costs of the production planning and control programs* and *computerized manufacturing systems*. The least preferences was given to the issue of *green manufacturing*. The analysis showed that regarding the process based on production planning and control i.e. *help of robots* and *maintenances hours in relation to working hours*, 77.1% and 76.3% of the organization reported their implementation for lesser than 25.0% of the times in the organization while 21.2% and 22.9% of the organization reported their implementation for 25.0 - 50.0% of the times. Similarly, on the implementation of *hydraulic and pneumatic systems* in the organization 43.2% organization reported their usage for 25.0 – 50.0% of the times while 33.9% of the tem reported their usage for lesser than 25.0% of the times.

Table 6: Response Analysis (Mean) of the Respondents on Quality Control

S. No	FACTORS	No. of Companies Scoring Points				Total No. of Responses (N)	Total Points Scored (TPS)	Percent Points Score (PPS)
		A	B	C	D			
		1	2	3	4			
1.	Whether your organization, test products under actual conditions?	8	14	64	32	118	356	75.4
2.	Does your organization carry out Life Cycle Analysis of the Product?	28	61	17	12	118	249	52.7
3.	Does your organization use technology to analyze quality?	30	37	39	12	118	269	57.0
4.	Does your organization issue computerized Quality Control instructions?	41	53	24	0	118	219	46.4
5.	Up to what Extent, the product needs to be re-processed after inspection?	86	28	2	2	118	156	33.0
6	To what Extent your organization, invest on Quality Control & Inspection fraction as compared to total production cost?	51	42	23	2	118	212	44.9
(Total Points Scored ‘TPS’ = A x 1 + B x 2 + C x 3 + D x 4)								

The response analysis results showed that the process of quality control based on the idea that “*tests product materials under actual conditions*” was given the maximum weightage in the organizations which was followed by the thrust to the ideas based on *technology to analyze quality* and *life cycle analysis of the products*. The least preferences were given to the issue of *issuances of the computerized quality control instructions*. The analysis showed that regarding the process based on quality control i.e. *reprocessing of the products after inspection*, 72.9% of the organization reported their implementation for lesser than 25.0% of the times in the organization while 23.7% of the organization reported their implementation for 25.0 - 50.0% of the times. On contrary, *on invest on quality control & inspection fraction as compared to total production cost* in the organizations 43.2% of them were using it less than 25.0% of the times while 35.6% of the organization was using it for the 25.0 – 50.0% of the times.

B. Correlation Analysis

Correlation analysis was performed in this section, the purpose was to identify the relationship between each statements within each parameters of the manufacturing competencies. Moreover, the direction of perception was measured by using correlation by assessing statements as all were measured on the same scale. The correlation process was Karl Pearson Correlation with significances level 0.05.

Table 7: Karl Pearson Correlation Matrix for the Product Concept

	Product Concept -1	Product Concept -2	Product Concept -3	Product Concept -4	Product Concept -5	Product Concept -6
Product Concept -1	1	.387**	.592**	.401**	.171	.453**
Product Concept -2	.387**	1	.569**	.507**	.174	.597**
Product Concept -3	.592**	.569**	1	.541**	.292**	.525**
Product Concept -4	.401**	.507**	.541**	1	.412**	.614**
Product Concept -5	.171	.174	.292**	.412**	1	.393**
Product Concept -6	.453**	.597**	.525**	.614**	.393**	1

The correlation analysis results showed that the product concept based on the idea that “*well planned structured concept generation process*” in the organization was well positively correlated with the other product concepts like “*company policies to promote innovation, marketing department motivated enough to bring up new concepts, developments of inter departmental relationships for new ideas and centralized planning structure development*” and similar of the results was evident with the product concept idea i.e. *company polices for*

innovations. As above discussed both product concepts was not correlated with the product concept of “flexibility of organization for making changes to satisfy customers”.

Table 8: Karl Pearson Correlation Matrix for the Product Design and Development

	Product Design & Dev - 2	Product Design & Dev - 3	Product Design & Dev - 4	Product Design & Dev - 5	Product Design & Dev - 6	Product Design & Dev - 7
Product Design & Dev - 1	.859**	.445**	.449**	.627**	.595**	.530**
Product Design & Dev - 2	1	.403**	.420**	.641**	.472**	.549**
Product Design & Dev - 3	.403**	1	.236*	.484**	.522**	.454**
Product Design & Dev - 4	.420**	.236*	1	.566**	.504**	.424**
Product Design & Dev - 5	.641**	.484**	.566**	1	.558**	.495**
Product Design & Dev - 6	.472**	.522**	.504**	.558**	1	.534**
Product Design & Dev - 7	.549**	.454**	.424**	.495**	.534**	1

On the assessment of the inter correlation between the statements based on the ideas regarding product design and development i.e. *existences of effective design technology program (CAD), higher usage of designing with computer aid, usage of computerized technology for analysis, usage of product life cycles, inclusion of aesthetics and ergonomics in product designing, usage of simulation and modeling for analyzing designs and tracking design and development costs*, it was evident that there was existences of strong and significant positive inter correlation between the each ideas based on product design and development.

Table 9: Karl Pearson Correlation Matrix for the Process Planning

	Process Planning - 2	Process Planning - 3	Process Planning - 4	Process Planning - 5	Process Planning - 6	Process Planning - 7	Process Planning - 8
Process Planning - 1	.821**	.721**	.364**	.468**	.629**	.563**	.245**
Process Planning - 2	1	.693**	.518**	.550**	.572**	.692**	.300**
Process Planning - 3	.693**	1	.526**	.589**	.645**	.506**	.297**
Process Planning - 4	.518**	.526**	1	.475**	.391**	.316**	.527**
Process Planning - 5	.550**	.589**	.475**	1	.437**	.456**	.559**
Process Planning - 6	.572**	.645**	.391**	.437**	1	.417**	.187*
Process Planning - 7	.692**	.506**	.316**	.456**	.417**	1	.255**
Process Planning - 8	.300**	.297**	.527**	.559**	.187*	.255**	1

On the assessment of the inter correlation between the statements based on the ideas regarding process planning i.e. *existences of effective process planning program, higher usage of process planning with computer aid, usage of group technology, usage of mechanism for material and machine selection, software based for planning regularly updated and reviewed with technological advancement, tracking process planning costs, preferences to departments integration and taking account of finishing and assemble of products*, it was evident that there was existences of strong and significant positive inter correlation between the each ideas based on process planning.

Table 10: Karl Pearson Correlation Matrix for the Raw Material and Equipment

	Raw Material & Equipment - 2	Raw Material & Equipment - 3	Raw Material & Equipment - 4	Raw Material & Equipment - 5
Raw Material & Equipment - 1	.182*	.246**	.709**	.561**
Raw Material & Equipment - 2	1	.619**	.147	.366**
Raw Material & Equipment - 3	.619**	1	.383**	.484**
Raw Material & Equipment - 4	.147	.383**	1	.550**
Raw Material & Equipment - 5	.366**	.484**	.550**	1

The correlation analysis results showed that the process of raw material and equipment based on the idea that “synergistically involvement of marketing, designing and production department in equipment selection” in the organization was well positively correlated with the other process concepts of raw material and equipment like “usage of ERP software of record keeping, existences of warehouse facility for inventory storages and availability of sufficient automated equipment with processing capabilities equivalent to market demands” but it was not correlated with the process concept based on the raw material and equipment of “existences of transportation facility”.

Table 11: Karl Pearson Correlation Matrix for the Production Planning and Control

	Prod Plan & Control - 2	Prod Plan & Control - 3	Prod Plan & Control - 4	Prod Plan & Control - 5	Prod Plan & Control - 6	Prod Plan & Control - 7
Prod Plan & Control - 1	.569**	.330**	.533**	-.170	.447**	.655**
Prod Plan & Control - 2	1	.519**	.394**	-.260**	.470**	.484**
Prod Plan & Control - 3	.519**	1	.267**	-.010	.508**	.557**
Prod Plan & Control - 4	.394**	.267**	1	-.195*	.510**	.436**
Prod Plan & Control - 5	-.260**	-.010	-.195*	1	-.278**	-.106
Prod Plan & Control - 6	.470**	.508**	.510**	-.278**	1	.410**
Prod Plan & Control - 7	.484**	.557**	.436**	-.106	.410**	1

The correlation analysis results showed that the process of production planning and control based on the idea that “maintenance hours in relation to working hours in organization” was well negatively correlated with the

other process concepts based on production planning and control like “usage of computerized manufacturing system, precise and accurate process, usage of robots and usage of hydraulic and pneumatic systems ” but it was not correlated with the process concept based on the production planning and control of “green manufacturing and cost tracking of production planning and control programs”.

Table 12: Karl Pearson Correlation Matrix for the Quality Control

	Quality Control - 1	Quality Control - 2	Quality Control - 3	Quality Control - 4	Quality Control - 5	Quality Control - 6
Quality Control - 1	1	.672**	-.204*	.561**	.379**	.591**
Quality Control - 2	.672**	1	.029	.668**	.567**	.646**
Quality Control - 3	-.204*	.029	1	.080	.277**	-.069
Quality Control - 4	.561**	.668**	.080	1	.644**	.716**
Quality Control - 5	.379**	.567**	.277**	.644**	1	.613**
Quality Control - 6	.591**	.646**	-.069	.716**	.613**	1

The correlation analysis results showed that the process of quality control based on the idea that “testing of products under actual conditions, life cycle analysis of the products, usage of technology to analyze quality, investment in quality control and inspection in references to total production cost and issuances of computerized quality control instructions” was well positively correlated with each other i.e. they had strong and significant positive inter correlation between each other. It was only with the one of the process of quality control i.e. *reprocessing of products after inspection*, it was evident that it was negatively correlated with the other process of quality control i.e. *testing of products under actual conditions* and *investment in quality control and inspection in references to total production cost*, whereas with rest of the process of quality control there was no evidences of any relationship between them.

V. Conclusion

From above analysis it is concluded that the parameters of Manufacturing Competency are highly correlated and they have a high internal consistency. Thus, the questionnaire is much reliable.

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