Factors that Facilitate Innovation in the Conventional Heavy Engineering Industry

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This study explores the relationship between components of structure and innovation. Components of structure include hierarchy, formalization, empowerment, centralization and participative decision making. Innovation is measured by number of innovations and perceived innovativeness. Results were analyzed using both quantitative and qualitative (content analysis) techniques. Significant relationship was found between hierarchy and innovation. A positive and significant relationship was found between formalization and innovation. A negative and significant relationship was found between centralization and innovation. A positive and significant relationship was found between participative decision making and innovation.

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Introduction

The design and practice of organization can be optimized to provide a base for constant innovation (Moore, 2004). Arora, Belenzon and Rios (2014) propose that firms pursuing innovations need a well-matched supporting structure for the purpose of innovations. Structure not only shapes innovation but plays an active role in successful implementation. Therefore the distinguishing organizational characteristics of innovative firms are of interest to researchers (Souitaris, 2002; Subramanian & Nilakanta, 1996). Subramanian and Nilakanta (1996) found the relationship between organizational characteristics and firm innovativeness. According to them innovativeness is a multidimensional construct. Organizational characteristics they studied were centralization, formalization and specialization. Truly innovative organizations, according to Subramanian (1996), are those that exhibit innovative behavior consistently over time. He proposes that an organization's strategic orientation reflects long-term or temporally enduring behaviors, innovativeness is also an enduring organizational trait.

Broadly innovation not only includes development of new products and services, but also new operating practices, processes, managerial tactics and even business strategies. It may not always be a process of creating, it is rather a process of building, improving and adapting (Youtie, 2003). An organization's structure can best be studied by using perceptual measures. Researchers like Hage and Aiken (1977), Daftaur (1988), Reddy (1997), Singh and Pestonjee (1988) among many others have studied and measured organization structure as a perceptual/behavioral variable. The current study is an exploratory research, partly behavioral in nature. The approach to the study of structure-innovation relationship suggested in the study may be regarded as a basis for speculative thinking and future research.

Objective

To study the relationship between components of structure and innovation in the heavy engineering industry of India.

Literature Review

Opportunity for growth and promotions is an important motivating/rewarding factor for employees to innovate (Anderson, Dreu & Nijstad, 2004). Smith and Ainsworth (2005) found that hierarchy presents opportunities for managers to meet power, authority and status needs, and have motivational affect for encouraging innovations. Leavitt (2003) found that despite their negative reputations many hierarchies have proved quite capable of change and have demonstrated impressive adaptability to change. He posits that hierarchies deliver a real, practical and psychological value by fulfilling a deep human need for order and security, hence, can facilitate innovations. On the basis of the above research, the following proposition was generated.

Proposition 1**:** Hierarchy has significant relationship with perceived innovativeness.

Formalization is required for effective implementation of creative ideas.

Significant positive correlation between formalization and implementation of innovations was found by Khandwalla (1995) in bureaucratic organizations of India. Weick (1998) found that formalization is required for effective implementation of creative ideas. Formalization settles ambiguity and uncertainty and greater autonomy and flexibility at implementation stage might even be harmful for innovations according to Drach-Zahany, Somech, Granot and Spitzer (2004). They found that formalization settles ambiguity and uncertainty. Wijnberg, Ende and Wit (2002) report that formalization increases accountability of decision makers towards each other and towards the organization. On the basis of the above researches the following proposition was generated.

Proposition 2: Formalization has positive relationship with perceived innovativeness.

Decentralization or low centralization according to Subramanian and Nilakanta (1996) facilitates innovativeness by encouraging new ideas as it promotes flexibility and openness in an organization. West (2000) found high centralization to be a negative predictor of innovations. In his study Vedamanickam (2001) found that decentralization was positively correlated with workplace innovativeness. Shavinina (2003) suggests that empowered multi-functional teams are more successful innovators. Kanter (2004) also found innovative organizations to be decentralized. McNulty and Ferlie (2004) posit that innovations increasingly require decentralization today. Findings of Khandwalla and Mehta (2004) indicate that extensive decentralization helped innovations. Hence, for Samaratunge (2003), decentralization facilitates innovation by improving democratic decision making, fostering responsiveness among employees, and enhancing the ability of junior management to influence senior management through empowered decision making. As for Stevenson (2012), centralized leadership promotes a mechanistic system, which is exhausted and no longer meets the needs of the growing complex systems today; as it assumes that only one or a few persons in an organization know everything, hence, can make the right decision. Schraagen, Veld and De Koning (2010) say that in response to the dynamic environment, organizations are increasingly adopting decentralized, team-based organizations, which have distributed power structures. In one research on an Indian sample Singh, Kodvani and Agrawal (2012) found that empowerment has a motivational effect on employees and significantly improves their performance and effectiveness. On the basis of above researches the following proposition was generated.

Proposition 3: Centralization has negative relationship with perceived innovativeness.

Where there was high level of participation in decision making, there was greater information sharing and interaction within groups.

West (1990) defines "Participative Safety" as a sense in team members that they can participate in the decision making process and share ideas without fear. He considers it important for innovation because participation in decision making engenders participative safety in employees. Khandwalla (1995) found positive correlations between participation in decision making and innovation in an Indian sample. Strauss, Heller, Pusic and Wilpert (1998) say participation fosters integration as they found that where there was high level of participation in decision making, there was greater information sharing and interaction within groups. These groups were more likely to work through difficulties associated with introduction of innovations and benefit from participation. Participative decision making for innovations is more effective in comprehensively solving an informational conflict. This not only increases the chances of success of innovations, but also increases receptivity to future innovation. Khandwalla and Mehta (2004) found that decisions in in-

novative-organic structures emerged through participation of those employees who were involved in and affected directly by a decision. Nayar (2010) discussing the participative environment of HCL Technologies, an Indian organization, says that employees are well connected providing each other with an environment that offers many alternative sources of information and resources that would otherwise not be available in non-participative environments. It helps to create a social network within the company, which has an informal structure. Kilduff and Brass (2010) propose that chances for innovation, collaboration, execution and learning complex information are increased in cohesive and participative networks within the company. Best (2012) stating the example of PricewaterhouseCoopers in America says that the chairman when setting up an innovation office got every single person to participate and communicate in the processes. On the basis of above literature the following proposition was generated.

Proposition 4: Participation in Decision-making has positive relationship with perceived innovativeness.

Perceived Innovativeness

In a study of 339 organizations, Bart (2004) measured firm-level innovation by asking respondents to indicate:

- How innovative they perceived their organization to be (using a 10-point scale).
- How important innovation was to their organization (using a 10-point scale).

Perceived innovativeness that the present study measures is similar to Bart's (2004) measure of firm-level innovation. The variable measures employee perceptions of how innovative they consider their organization is, the extent to which activities and processes in their organization are positive and facilitative of innovations, and the organization's approach towards innovations. Literature in documented form which studies variable like perceived innovativeness is rare. Hence, it maybe considered as a new variable.

Structure

Structure refers to the manner in which work and employees are organized in a firm; with the help of formal rules and procedures; by dividing them according to their functional expertise; by prescribing roles for employees; and by investing the power to take decisions at desired organizational levels in the desired personnel. Structure in the current study comprises five components:

1. *Hierarchy* refers to the degree to which an organization is divided vertically into various levels of hierarchy varying in the degree of authority enjoyed by each. This variable is measured by counting the total number of hierarchical levels and sub-levels in the organization between the top management and the lowest worker. Data was collected from secondary sources.
2. *Formalization* is defined in the study as the extent to which employee be-

havior and job/role- specifications are regulated and standardized by the use of formal rules, procedures, and task definitions in the organization. Formalization has been measured by Hage and Aiken's (1977) Formalization Inventory.

3. *Empowerment:* In the current study comprises two sub-components. These sub-components have also been analyzed as separate variables. Thus, empowerment is measured by combining two scales (one for each sub-component) into a single scale. These sub-components are:

4. *Centralization* refers to the degree to which authority for decision making in an organization is concentrated at a single point or organizational/ managerial level. Centralization is measured by the delegation of authority scale, devised by Daftaur (1988).

5. *Participative Decision Making* refers to the degree of participation of members from different hierarchical levels and functional units in an organization in the decision-making process. The variable is measured by Hage and Aiken's (1977) scale of personal participation in decision making.

Innovation

The dependent variable, innovation has been defined in the study as the introduction of a unique, new or modified product and/or process of production and/or functioning. For more accurate measurement of innovations, the variable has been divided into two measures:

1. *Number of Innovations r*efers to the total number of innovations introduced in the organization over a specific time period (7 years). It could include innovations in any functional unit, in new product development, product modification and improvement, and/or significant process modification and improvements, and new process development. This data was collected from employee interviews. Each innovation that employees mentioned was listed by the researcher verbatim. Employees were asked details about how each innovation benefitted the organization; that is, improved existing level of functioning, organizational income, brand-name and the like. Thereafter the responses were categorized as 'an innovation' or discarded 'not an innovation' or repetition. For innovation score, total numbers of innovations during 7 year period were added up, repetitions were cancelled. Subramanian and Nilakanta (1996) in a prominent research have also recorded and analyzed number of innovations over a 7-year period.

2. *Perceived Innovativeness* portrays employee perception of how innovative they consider their organization currently and in the past. The measure includes employee perceptions of their organization's overall approach to innovation. This includes the extent of encouragement provided to innovations in terms of resources and time devoted to innovations, other initiatives taken by the organization to promote innovations. It also includes special initiatives taken by the corporate group to foster innovations, also flex-

ibility and change in design aspects that may help innovations. Perceived innovation has been measured using a scale designed by the researchers.

Formalization Inventory

Formalization was measured by Hage and Aiken's Formalization Inventory cited in Miller (1977:284 -86). This scale consisted of 15 items to be rated on a 4-point rating scale, from 1-definitely true to 4-definitely false.

Dissatisfaction with work is high in organizations where jobs are rigidly structured.

The criterion validity of the scale has been given, the criterion measure used was 'alienation'. Formalization is positively related to '*alienation*'. Greater the degree of formalization in the organization, the greater is the likelihood of alienation from work. Dissatisfaction with work is high in organizations where jobs are rigidly structured. Strict enforcement of rules was strongly related to work dissatisfaction. Social relations are also disturbed when rules are strictly enforced. Significant positive relationships were found between routine work and rule manual, job description and specificity of job descriptions.

Empowerment Scale

The empowerment scale is formed by combining two scales, one for 'centralization' and the other for 'participative decision making'. The combined instrument had 8 items, 4 items from each of the two scales, both rated on a 5-point rating scale. The values on the scale varied in intensity from 1-never to 5-always.

Centralization Scale

Designed by Daftaur, cited in Pestonjee (1988: 233-34), this scale measures concentration of authority. It is a 5-point rating scale from 1-never to 5-always. Lower the concentration of authority score of an individual higher is the centralization score and vice versa. Cronbach's alpha coefficient of reliability is .95

Scale for Participative Decision Making

Hage and Aiken's scale cited in Miller (1977: 287-89) was used to measure participation-in-decision-making. It is a 5-point rating scale, from 1-never to 5-always.

The criterion validity measure used was 'autonomy'. Organizations in which decisions were made by only a few people at the top, relied on rules and close supervision as a means of ensuring consistent performance by the workers. The presence of a well trained staff is related to a reduced need for extensive rules. Organizations that are highly autonomous tend to have a non-participative internal decision structure. Greater the autonomy, larger is the executive's span of control.

Scale for Perceived Innovativeness

It assessed how innovative employees perceive their organization to be. It also assessed employee attitudes of the

organization's overall approach towards innovations. It consisted of 20 items, to be rated on Likert-type 5–point rating scale from 'strongly disagree-1' to 'strongly agree-5'. On an item, a score of 5 indicated highest score on perceived innovation, while 1 indicated lowest score. Test-retest reliability was .86. Internal consistency validity calculated by the inter-item consistency method was .90.

The Interview Schedule

In-depth interviews were used to supplement the questionnaires in data collection. Interview data was analyzed qualitatively using content analysis. Questions in the interview schedule were semi-structured and open ended, focusing on all different relationships studied in the current research.

Sample & Data Collection

A stratified random sample of 150 employees from heavy engineering firms in India participated in the study. All employees were subject to questionnaires, while 100 employees were subject to in-depth interviews. Participants for the study belonged to four different management levels, 39 from senior management, 28 from middle management, 31 from junior management and 52 from supervisory staff. The researcher personally approached each employee participating in the study for distribution and collection of questionnaire responses. By confirming prior appointments participants were interviewed face to face by the researchers. Data was collected from heavy engineering firms located in two metropolitan cities of India.

Correlation

Formalization shows positive and significant relationship with perceived innovation ($r = .46$, $p<.01$). The relationship between empowerment and perceived innovation was not significant. Centralization shows a desired negative and significant relationship with perceived innovation ($r = -.20$, $p<.05$). Participative decision making shows positive and significant relationship with perceived innovation ($r = .17$, $p<.05$).

One Way ANOVA

Hierarchy shows significant relationship with perceived innovativeness ($F=15.24$, $p<.01$). Formalization also has a significant relationship with perceived innovativeness ($F=22.41$, $p<.01$). There is a significant relationship between centralization and perceived innovativeness ($F=4.32$, $p<.05$). However significant relationship was not found between empowerment and perceived innovativeness, and between participative decision making and perceived innovativeness.

Discussion

Results show significant relationship between hierarchy and innovation. A high significance ANOVA value provides support. However 39.78% employees say that hierarchy facilitates innovation. Hence, proposition 1 has been partly supported by the findings. Mostly literature presented earlier in the paper is support-

Qualitative Results

Relationship between Structure Components and Innovation:

39.78% were in favour of positive relationship between Hierarchy and Innovation	**77.42% employees were in favour of negative relationship between Centralization and Innovation**
*Flat organization structures do not give ample opportunities to employees for vertical growth which is a major motivating factor for innovating. *Hierarchy encourages employees with opportunities for promotion as reward for their innovative ideas and endeavors. *In flat structures, employees of varied seniority/experience and qualification were placed at the same level. This resulted in problems of adaptation between junior and senior employees placed at the same organizational level. So, hierarchy is important. * In flat structures there is more confusion. *There is more clarity with hierarchy, hence, less conflict and stress in a tall hierarchy	*Decentralization helps the organization to respond to changing market conditions and competition. *Decentralization helps innovation since decision making is faster. *It can be regarded as a stimulating factor for encouraging employees to take control of their tasks. *With decentralization comes greater flexibility in one's performance of duties. *There are more opportunities of doing things in different ways, and hence innovation. *Employees were free to prioritize and time their work accordingly. *For every work we do not have to consult or depend completely upon senior levels, hence, greater time and motivation for innovation. *For every decision employees did not have to wait for long, for decision-makers to be available. *Decentralization was positive for both, initiation as well as implementation of innovations.
81.72% were in favour of positive relationship between Formalization and Innovation	**82% employees were in favour of positive relationship between Participative Decision Making and Innovation**
*Rules & procedures create discipline. *Rules create responsibility among employees. *Rules are important for delivering deadlines and reaching targets, hence, for retaining customers. *Rules are important for smooth functioning of multi-functional product teams. *In cross-functional teams rules are important for coordination of different functional experts. *Rules are important for implementation of innovations.	*When ideas come from various levels in an organization, and are then discussed in groups representing different functions and levels of hierarchy; it is an enriching exercise for innovations. *The potential market impact of an idea is also discussed in participative environments. *Ideas that are found weak are rejected quickly with consensus after discussion. *Participation is helpful for idea generation. *Participative decision making also helps in implementation of innovations. *Participative decision making facilitates Innovation, as it helps the organization to come up to the competitive standards of the market.

ive of a positive relationship between hierarchy and innovation.

Formalization shows a positive and significant relationship with perceived innovativeness as both correlation and ANOVA scores show highly significant values. Qualitative findings also indicate a positive relationship between formalization and innovation, as 81.72% employees indicate that formalization facilitates innovations. This is supported by a majority of research presented in literature review. Hence, proposition 2 has been supported.

Centralization shows a desired negative relationship with perceived innovativeness. Besides a negatively significant correlation and significant ANOVA scores, qualitative results lend strong support. 77.42% employees say that low centralization (decentralization) facilitates innovation and favors a negative relationship between centralization and innovation. Research presented in literature review shows that centralization is a negative predictor of innovations, and decentralization is a facilitator of innovation. Proposition 3 has thus been supported.

Participative decision making shows significant and positive relationship with perceived innovativeness. Hence, proposition 4 has been supported. ANOVA findings however do not offer support to correlation findings. Qualitative findings offer strong support to correlation findings. 82% employees clearly indicate support to a positive relationship between participative decision making and innovation.

Empowerment though does not show significant relationship with perceived innovativeness statistically, but has been supported by qualitative findings.

Implications

India's conventional heavy engineering sector, especially the transmission and distribution industry, manufactures tailor-made heavy or fabricated products, hence, the industry is largely labor intensive. Their workforce consists of skilled, semi-skilled and unskilled workers. The highest number consists of semi-skilled workers. Also the junior management of the firms studied mostly consists of young and fresh professionals. These are some reasons why empowerment seems to suffer, to some extent, in the organizations studied. However, they are evolving organizations, so decentralization is slowly picking up. Formalization according to some experienced managers is high in these organizations for similar reasons. Only the more experienced and skilled managers are considered safe for decision making. Rules need to be strictly implemented as employees of different skill levels are expected to deliver quality standards customized to customer requirements.

Normally flattening a hierarchical organization should be a motivation booster for employees, and hence facilitate innovations. However in the heavy engineering organizations studied this has not helped in speeding up decision-making much. It rather has increased the conflicts and adaptation problems within teams. The problem has implications for

change absorption and training issues. Their maybe the requirement for desired training and ice-breaking workshops before the change is implemented. The employees report problems of adaptation when employees of different skills and seniority levels are made to work as near equals in the new situation.

To promote a participative environment it is important to break hierarchical and functional barriers.

It would be beneficial to incorporate suggestion schemes which would especially help the junior management and supervisory levels in these firms to contribute their ideas without fear of evaluation, hence, engender participative safety (West, 1990). These suggestion schemes need to be closer to open-house rather than just dropping suggestions in boxes. Participative discussions involving different organizational levels and functions would help to brainstorm and discuss implementable solutions. This is not only likely to speed up idea-generation and implementation, but also promote free-flowing communication. To promote a participative environment it is important to break hierarchical and functional barriers. In the Indian manufacturing sector where the culture is generally more conventional and motivated by bureaucracies, hierarchical and functional barriers exist. Some studies have also stated evidence. Agrawal (2010) found that manufacturing firms of India fare poorly as far as working relationships between line managers and HR managers is concerned. Promoting a participative environment, participative discussion forums, open-house, collective and participative decision making help develop social networks within the organization which, most of the time, transcend hierarchical and functional barriers. This also leads to a greater acceptance of people, appreciation of ideas and perspectives, helping in quick decision making. Cross, Nohria and Parker (2002) found that informal networks often provide the glue that holds together cross-functional process improvement initiatives. These groups could significantly contribute to process innovations.

As an example Nayar (2010), former CEO of HCL Technologies India, expressed when referring to his experience of introducing the collaborative and participative network in the company: "it seemed that everybody wanted to help their CEO and had an opinion on the problem, questions were going both ways". He shares that no one person can have all the answers and every employee's suggestions or thoughts mattered. These networks would bring greater transparency in the system and help to build trust (Nayar, 2010). According to Agrawal and Tyagi (2010) there is high value for collaboration in the manufacturing sector of India. Hence it may be correct to assume that such collaborative and participative networks could benefit the heavy engineering units also.

It is also important to implement team-based reward system in the organizations, which would assure fair opportunity for all team members to be re-

It is also important to implement team-based reward system in the organizations.

warded. Providing continuous performance feedback to employees will also be helpful for innovations. Recognition programs should acknowledge efforts of employees at different organizational levels, including the lower most. Overall, the approach to recognition should be as inclusive as possible.

The above discussion has important implications not only for innovation but also for a holistic approach to business management, ensuring welfare of all business constituents. Corporate Stakeholder's Management (Shah & Bhaskar, 2011), where the organization and its top management works for the satisfaction of its primary stakeholders, its very own employees. Such an organization ensures welfare of all its employees, builds trust, promotes openness, collaboration and communication (Shah, 2014). The organization needs to get all stakeholders fully on board for innovation initiatives to drive them to success. It is a process to structure the organization to become an optimal environment for innovation to thrive. Like in PricewaterhouseCoopers, the chairman while setting up an innovation office involved each and every employee to participate in the process (Best, 2012).

Contributions

1. This single study explores effect of five structure components (hierarchy, formalization, empowerment, centralization and participation in decision making) on innovation, hence is enriching.
2. Innovation is measured in two parts. The perceptual measure of innovativeness, perceived innovativeness, is measured by a scale designed by the researchers. This is a fairly new variable, since it is difficult to find a documented counterpart in the literature available.
3. The objective measure of innovation is the total number of innovations, which has been recorded by responses of in-depth interviews. The time-span for these innovations was 7 years. Each innovation reported by employees was listed verbatim by the researchers. Employees were asked to indicate the significance of each innovation mentioned by them for the organization. On the basis of the contribution of each innovation to the organization and the operational definition of the variable, innovations were identified. These innovations were further categorized as input, throughput and output level innovations.
4. This study takes a positive view of formalization, contrary to the popular research evidence. It proposes a positive relationship between formalization and innovation. It proposes that formalization on one hand may have advantages for implementation of innovations it may not facilitate or even inhibit idea-generation.

The approach to the study of structure-innovation relationship suggested in the present research may be regarded as a basis for speculative thinking and future research, rather than as a guide to action. Correlations are presented and explained, but should not be mistaken as causations, and findings have been put forth as observations.

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