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A Delphi-AHP-TOPSIS based framework for the prioritization of intellectual capital indicators: A SMEs perspective

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Abstract

Small Medium Enterprises (SMEs) are major players in the global economy. Emerging clusters are very common in India. These emerging clusters facilitate competitive advantages and growth of the economy. The paper aims to develop a framework that prioritizes potential alternatives and suggest a critical indicators of intellectual capital (IC). A Delphi-AHP-TOPSIS methodology is used and the study is carried out in SMEs manufacturing unit located in central northern part of India. Here, Delphi method is an iterative process and is used in order to analysis of techniques and brainstorming for problems, opportunities and a novel consistent intellectual capital scale is developed. Analytic hierarchy process (AHP) is used to determine the weight of indicators as criteria and technique for order of preference by similarity to ideal solution (TOPSIS) is used to obtain final ranking of IC indicators. The proposed framework can support directors to point out the strengths and weaknesses of IC indicators. The inter-relationship between IC indicators can also understood by the managers of the SMEs manufacturing unit with the help of these framework. SMEs manufacturing unit directors may utilize the findings of this paper as base for optimal investment of funds in IC indicators. Due to the wide range application of Delphi-AHP-TOPSIS, it has been an important research subject for many researchers with context to SMEs.

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Keywords: Intellectual capital; small medium enterprises; manufacturing; Delphi; AHP; TOPSIS

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1. Introduction

Small Medium enterprises (SMEs) has become the growth driver of the Indian economy. Many new clusters have been developed and are adding competitive advantage to the similar kind of industries. These clusters are highly competitive in nature and having sustainable growth rate. The SMEs sector in India contributing almost 17.8% to the GDP (Gross Domestic Product) and are generating 39.3% of the total workforce in the nation. Furthermore, the money spent and attention given by the SMEs on the training and development of their human resource increased significantly. F-Jardon & Martos (2012), suggests Intellectual capital (IC) provides more competitive advantage in SMEs as compared to large organisation because of lower tangible resources in SMEs. Cheng et al., (2004) in one of their study stated that, IC has received a little attention in developing countries with reference to SMEs. As it contributes to sustained competitive advantages and derived from knowledge-based resources. Likewise, (Pablos, 2002) stated that successful organizations are used to maximize their value of their intellectual capital. Therefore, the SMEs will receive the greater performance and competitive advantage if they devote more time in managing IC. It is recognized as the fundamental factor in gaining competitive advantage of the SMEs. Today, it is more important to understand the importance of IC and how to manage IC creating and maintaining the right equilibrium among IC components to survive in the competitive economy. Actually most of the SMEs have vague ideas of how to manage investments in IC and what they should obtain from these investments. Nevertheless, managing investments and evaluating the indicators of IC is essential for all the SMEs that understand the new rules of survival in the competitive business environment. Lev (2003), stated that most IC indicators are difficult to measure quantitatively because they are intangible in nature. For these reason, directors, practitioners and managers of the SMEs are greatly supported by the MCDM (AHP-TOPSIS) technique for the evaluation of the IC indicators. There are unfortunately few researchers who have focused on the prioritization of IC indicators by using the Delphi-AHP-TOPSIS approach in the SMEs manufacturing unit located in the central northern part of India. This gap in the earlier researches is the main focus of the present study. Therefore the objective of the paper is to develop a framework that prioritizes potential alternatives and suggest a critical indicators of IC by using AHP-TOPSIS approach. It is critical to understand the IC indicators for the better progress and developments of the SMEs. The study considers the following indicators of the IC in the present study.

- **Human Capital (HC):** HC is considered as the source of innovation and strategic renovation. It comprises employee’s creativity, attitude, knowledge, skills, motivation level, competence level, and experience of the employees.
- **Structural Capital (SC):** These are used in the relationships and contacts with people outside the organization. It includes operation process, organizational learning activity, information system and corporate culture.
- **Relational Capital (RC):** It is the overall customer satisfaction, brand value, relationship with suppliers, competitors and organisation to stimulate potential and thus creates wealth, which then increases the HC and SC.
- **Innovation Capital (ICP):** It includes innovation mechanism, culture and innovation achievements related activity of the organisation.
- **Customer Capital (CC):** It includes the customer loyalty, marketing capability, market intensity and customer appropriateness.

In these paper, SMEs (manufacturing unit) located in the central northern part of India are considered for the study. Five dimensions of IC are extracted from the existing literature viz. HC, SC, RC, IC and CC. Applying the intellectual capital perspective, this study examines how the various dimensions of IC contribute to firm performance. Multi criteria decision making (MCDM) methodology are adapted to deal with the development of framework and prioritization of intellectual capital indicators. A Delphi-AHP-TOPSIS approach is used aiming at solve this kind of problem. In these approach, AHP is used to determine the weight of the attributes and TOPSIS is used to determine the overall ranking of the IC indicators.
2. Literature review

Intellectual capital (IC) demarcated as the knowledge and knowing capabilities of a social collectivity (Nahapiet and Ghoshal, 1998). Likewise, many authors, (Dumay, 2009; Edvinsson and Malone, 1997) defined IC from accounting perspective as the difference between market value and book value of the firm. In other words we can say that IC is the knowledge that firms utilise for competitive advantage and it includes HC, SC, RC, ICP, and CC. Many earlier authors (F-Jardon & Martos, 2012; Chen et al., 2004; Bontis, 2001; Edvinsson & Malone, 1997) have conferred upon the importance and content of IC. In addition, researchers that focused on the current state of IC research (El Tawy and Tollington, 2012; Tan et al., 2008). Likewise, (Hancock et al., 2007) posits that there is a correlation between IC and firm performance and they are dependent on each other. The synergy between innovation capital and information technology are having effect on firm performance were reported by (Huang and Liu, 2005). They concluded that there is a positive effect on firms’ performance, after considering the interaction between innovation capital and IT capital, and the firms should coordinate different perspectives of IC to improve firm performance. Many authors (Litan & Wallison, 2000; Blair & Wallman, 2000) have suggested that the importance of IC has grown with the arrival and ascendance of the information age and the virtual economy. In recent decade IC has been shown to have an impact on firm performance and allows the organisation to produce higher-valued assets. Bontis (1999), in one of his work distinguished human, relational and structural types of capital and stated that IC theory has been adopted to understand knowledge contribution (Wasko and Farajm, 2005) and the quality of knowledge sharing (Hooff & Huysman, 2009) to the organisation. Here, we have considered IC to be our foundation as we attempt to understand its effect on the SMEs performance.

In 1998, Bontis considered the three dimensions of IC (HC, SC, RC) and suggested that these three dimensions affect the firm performance. However, he does not assert the relation between each dimension. In 2005 Wang and Chang, classifies IC into four elements (HC, CC, ICP and process capital) and suggested each element directly affects firm performance and each element are interrelated with each other’s. Likewise, (Bontis et al., 2000) asserted IC has important and viable relation to the enterprise performance, whatever the considered industry. Tovstiga and Tulugurova (2007), conducted their study in logistic industry and explored the causal relation between dimensions of IC and firm performance and stated that there is positive relation between the dimensions of IC and are not differ from the region to another one (America, Asia and Europe,). Wang and Chang (2005), considered four types of capital, i.e., human, innovation, process, clients and concluded that all dimensions of IC have direct impact on firm performance except the HC.

Pablos (2004), in one his study analyzed the interrelation between dimensions of the IC (HC, SC and RC) and posits HC has a significant effect on the development of RC and SC. SC, CC and IC affiliated to HC. RC shows significant effect on SC. Likewise, (Jardon and Martos, 2008) emphasize relational capital is consequence of the structural capital. HC is the source of other dimensions of IC and relational capital are source of structural capital. Human capital directly influences the development of RC and SC (F-Jardon and Martos, 2009). The only dimension of IC that directly influences firm performance is structural capital. However, it is necessary to maintain HC because it is the source of IC. In addition, (Wang and Chang, 2005) suggested that there is a need to put more emphasis on the dimensions of IC. As it has become the source of competitive advantage for the SMEs whatever their nature.

<table>
<thead>
<tr>
<th>SL No.</th>
<th>Dimension</th>
<th>Author(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Human capital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Employees’</td>
<td>Kim &amp; Kumar (2009); F-Jardon &amp; Martos (2009);</td>
<td>Comprises knowledge, skills, abilities, qualities, talents etc. of</td>
</tr>
<tr>
<td></td>
<td>competence</td>
<td>Chen et al. (2004); Bontis (1998); Sveiby (1997); Brooking (1996); Kaplan and Norton (1993)</td>
<td>employees. Includes employee level of satisfaction, turnover rate, and</td>
</tr>
<tr>
<td>b.</td>
<td>Employees’</td>
<td>Kim &amp; Kumar (2009); F-Jardon &amp; Martos (2009);</td>
<td>Comprehends employee specialty and his ability for continuous</td>
</tr>
<tr>
<td></td>
<td>attitude</td>
<td>Wang and Chang (2005); Chen et al. (2004); Bueno et al. (2003); Bontis (1998)</td>
<td>innovation. Encompasses motivation for work and satisfaction for work.</td>
</tr>
<tr>
<td>c.</td>
<td>Employees’</td>
<td>Asontis &amp; Kostagiolas (2010); Chen et al. (2004); Brooking (1996)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>creativity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Motivation of the</td>
<td>F-Jardon &amp; Martos (2009); Edvinsson and Malone (1997); Kaplan and Norton,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>personnel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Structural Capital  
   a. Corporate culture  
      Kim & Kumar (2009); F-Jardon & Martos (2009); Wang and Chang (2005); Chen et al. (2004); Bueno et al. (2003)  
      Includes ethics, faith, behavior criteria approved and shared by all staff.
   b. Organizational structure  
      Moon and Kym (2006); Chen et al. (2004); Bontis et al. (2000); Sveiby (1997); Brooking (1996)  
      Encompasses the policy-making, leading, controlling, and the information structure.  
      Involves utilization of inner information and repository of the firm.  
   c. Organizational learning  
      Asonitis & Kostagiolas (2010); Chen et al. (2004);  
      Comprises operational tasks, working methods of the firm.  
   d. Operation process  
      Asonitis & Kostagiolas (2010); Chen et al. (2004)  
   e. Information system  
      Asonitis & Kostagiolas (2010); Kim & Kumar (2009); Chen et al. (2004)  
      Comprises of storage, transmission and disposal of inner information of firm.

3. Relational Capital  
   a. Brand value  
      Asonitis & Kostagiolas (2010); Kim & Kumar (2009)  
      Incorporates brand is worth in terms of income, status, and market value.  
      Helpful in reshaping the relationship with suppliers can create win-win situation and increase the profitability of both parties.  
      Includes customer expectations, perceived quality, and perceived value.  
   b. Relationship with suppliers and competitors  
      F-Jardon & Martos (2012); F-Jardon & Martos (2009); Welbourne and Pardo-del-Val (2008); Bueno et al. (2003); Kaplan and Norton (1993)  
      Involves cooperation with other bodies and sharing similar aims for future development activities.
   c. Customer satisfaction  
      Asonitis & Kostagiolas (2010); Kim & Kumar (2009); Mayo (2001); Bontis (1998); Roos and Roos (1997)  
   d. Relationship with other organisation  
      Asonitis & Kostagiolas (2010); F-Jardon & Martos (2009); Bueno et al. (2003)  

4. Innovation Capital  
   a. Innovation achievements  
      Asonitis & Kostagiolas (2010); Chen et al. (2004)  
      Includes copy rights, new products, and technologies obtained through the technical innovation.  
      Involves the investment, operation, cooperation, and motivation mechanism.  
      Includes support and encouragement to employees’ innovative mechanism.
   b. Innovation mechanism  
      Asonitis & Kostagiolas (2010); Chen et al. (2004)  
   c. Innovation culture  
      Asonitis & Kostagiolas (2010); Chen et al. (2004)  

5. Customer Capital  
   a. Marketing capability  
      F-Jardon & Martos (2012); Chen et al. (2004); Carson and Gilmore (2000)  
      Encompasses identifying ability of customer needs, serving capability, and the capability of collecting and utilizing customers’ data.  
      Contains market share, potential, brand and trademark reputation.  
      Involves customer satisfaction, outflow, complaint, price tolerance, and customer relationship.  
      Encompasses customer expectations of a firm’s service, and the element of customer satisfaction and market orientation.
   b. Market intensity  
      Asonitis & Kostagiolas (2010); Chen et al. (2004)  
   c. Customer loyalty  
      Kim & Kumar (2009); F-Jardon & Martos (2009); Chen et al. (2004)  
   d. Customer appropriateness  
      Cohen & Kaimenakis (2007); Mayo (2001); Bontis (1998); Roos and Roos (1997)

6. Firm Performance  
   a. Net profits  
      F-Jardon & Martos (2009); Darroch (2005); Bontis et al. (2000)  
      Includes net earnings or income and shows relationship between net profit after tax and net sales of the firm.  
      Includes ability of firm to produce and commercialize a flow of...
3. Research Methodology

Initially 75 high level managers of SMEs manufacturing unit located in central northern part of India, having knowledge of organisation’s goals, strategies, and involved in decision-making process were approached to participate in the Delphi-AHP-TOPSIS decision making process. The panellists were identified using “convenience sampling” (experts are selected because of their convenient accessibility and proximity to the researcher) approach. The panellist were informed of the objectives of the study and assured that all the responses delivered by them were kept limited to study purpose only. The respondents who have not answered could also systematically contacted over telephone in order to resolve the issues and these follow-up would be helpful in reducing the case of non-response bias in the current study.

Table 2. Respondents Profile (SMEs manufacturing unit located in central northern part of India).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Respondents profile</th>
<th>No. of respondents</th>
<th>Respondents qualification</th>
<th>Experience in years.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Line managers</td>
<td>21</td>
<td>Graduate</td>
<td>More than five years</td>
</tr>
<tr>
<td>2.</td>
<td>Senior manager</td>
<td>12</td>
<td>Post Graduate</td>
<td>More than eight years</td>
</tr>
<tr>
<td>3.</td>
<td>Director</td>
<td>6</td>
<td>Post Graduate</td>
<td>More than twelve years</td>
</tr>
</tbody>
</table>

3.1 Delphi method

The Delphi process has several advantages. First, each member of the panel can be involved in each step of the process; secondly, no member is ever required to defend his or her position; and thirdly, the process allows for natural development of a trend or consensus.
The modified Delphi method comprises of five steps:

(1) Selection of Experts;
(2) Piloting the first round of a survey;
(3) Conducting the second round of a questionnaire survey;
(4) Conducting the third round of a questionnaire survey; and
(5) Assimilate a group of experts’ opinions and to reach a consensus.

Here, steps (3) and (4) are repeated until a consensus is reached on a particular topic (Chang et al., 2008; Gumus, 2009). After the third round there is a consensus among the expert panel on the dimension and items that are being considered for study. For that reason, the Delphi method is considered as one of the best-known consensus-reaching methodologies.

3.2 The Analytic Hierarchy Process

AHP is the decision making method that helps in making judgement by decomposing a complex problem into a multi-level hierarchical structure, which includes objectives, criteria, sub-criteria, and alternatives. Likewise, many authors (Reisinger et al., 2003; Clinton et al., 2002) indicated that AHP methodology as one of the best methodologies to prioritize various IC indicators.

AHP comprises of three essential stages:

Stage-1 Hierarchical structure creation of the decision problem.
Stage-2 Pair wise judgments via a structured questionnaire that yield relative priorities (local weights) on the identified criteria.
Stage-3 Synthesis of the relative priorities (local weights) into the global priorities (global weights) that lead to the selection of the final decision.

Then, in the fourth level, motivated employees that particularize the decision elements of the third level are included (figure 2). Pairwise comparison are done through Saaty 9-point scale. Normalized weights matrices in obtained in the next phase of the process.

3.3 TOPSIS Method

TOPSIS (Technique for order of preference by similarity to an ideal solution) method is multi criteria decision making technique facilitates the decision maker to organize the problem in a simple manner; carry out analysis, comparison and ranking of alternatives of the real world problem as suggested by (Hwang and Yoon, 1981). The alternatives ranking are based on the shortest distance from the positive ideal solution (PIS) and the farthest from the negative ideal solution (NIS). Cheng et al., (2000),commends TOPSIS as the utility based method because it compares each alternative directly depending on the data in the evaluation matrices and weights. Likewise, (Shih et al., 2007) highlighted the use of TOPSIS and posits due to its logical reasoning the method has solved many real-world problems, especially in recent years in the Asian Pacific region.

The TOPSIS procedure comprises of the following steps (Jamali & Tooranloo, 2009):

1. Compute the normalized decision matrix.
2. Computation of weighted normalized decision matrix.
3. Ideal and negative-ideal solution are determined.
4. Calculation of separation measures, using the n-dimensional Euclidean distance.
5. Computation of relative closeness to the ideal solution.
6. Rank the preference order.
Table 3. Final Priority of IC Indicators and firm performance in SMEs manufacturing unit.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Main criterion (MC)</th>
<th>Priority Vector (MC)</th>
<th>Sub-dimensions (SD)</th>
<th>(Consistency ratio)CR</th>
<th>Priority Vector (SD)</th>
<th>Distance from positive deal</th>
<th>Distance from positive deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Human capital</td>
<td>0.3851</td>
<td>Employees’ competence (EC)</td>
<td>0.086</td>
<td>0.2782</td>
<td>0.0164</td>
<td>0.0224</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Employee creativity (ECR)</td>
<td>0.2028</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Motivation of the personnel (MP)</td>
<td>0.1845</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Staff’s experience (SE)</td>
<td>0.1776</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Employees’ attitude (EA)</td>
<td>0.1570</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Structural capital</td>
<td>0.3521</td>
<td>Organizational structure (OS)</td>
<td>0.076</td>
<td>0.2557</td>
<td>0.0162</td>
<td>0.0230</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Organizational learning (OL)</td>
<td>0.2488</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operation process (OP)</td>
<td>0.1756</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Information system (IS)</td>
<td>0.1668</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Corporate culture (CC)</td>
<td>0.1531</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Relational capital</td>
<td>0.2846</td>
<td>Brand value (BV)</td>
<td>0.084</td>
<td>0.2606</td>
<td>0.0178</td>
<td>0.0214</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Relationship with suppliers and competitors (RSC)</td>
<td>0.2562</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
While forming AHP-TOPSIS hierarchy model, five different dimensions of IC, and firm performance are considered in the present study. This is given in Table 1. Based on a hierarchy of factors, AHP model is developed as shown in Figure 2. The model used for prioritization of factors considered in this study. Pairwise comparison, judgment matrices formed for determining the normalized weight. Consistency ratio (CR) calculated for checking the degree of consistency in the pairwise comparison. TOPSIS is used to obtain final ranking of IC indicators and firm performance sub-dimensions. While analysing the results, it is found that all the decision by expert team is consistent as the CR value is less than <0.1. It denotes that the opinion made by the experts is all right for further analysis.

In addition, Table: 3 exhibits the final priority of IC indicators and firm performance in SMEs manufacturing unit. The results drawn from the analysis with respect to the HC is EC> ECR> MP> SE>EA. It shows that the EC is the best alternative among all the alternative considered for the present study. The result is in line with the earlier researches undertaken by (F-Jardon & Martos, 2009; Chen et al., 2004). As these employee competence vary from employee to employee, from job to employee job position. However, there are some fundamental competencies that are remain with all the employees. There is a need to focus more on EA attributes of human capital. Likewise, for structural capital OS>OL>OP>IS>CC. Here, the best alternative is the OS and followed by others. It shows that better will be the OS higher will be the customer attraction as well as higher will be the performance. The result is in line with the earlier researches carried out by (Moon and Kym, (2006). As well for the relational capital BV>RSC>RO>CS. With reference to relational capital the best alternative is BV and followed by others. So it is necessary for the SMEs to focus more on CS for their better development. The result is in line with the earlier study conducted by (Kim & Kumar, 2009). With respect to the customer capital CL>CAP>MCP>MI. Here, CL is the best alternative and followed by others with reference SMEs. The result is in line with the earlier researches conducted by (Chen et al., 2004). It shows that higher the CL higher will be the net profit as well as market intensity. Similarly for the innovation capital ICR>IM>IA. With reference to innovation capital for SMEs manufacturing unit, it necessary to promote the innovation culture or the trend for the purpose draw more innovation achievements at SMEs. The result is in line with the earlier researches undertaken by (Chen et al., 2004). In addition for firm performance B1>B2>B3>B4>B5. It shows that SMEs manufacturing unit needs to be more competitive and innovative in their approach for their better progress in future endeavours. The result is in line with the earlier researches conducted by (F-Jardon & Martos, 2012).
5. Findings

In these paper, multi criteria decision-making (MCDM) is used to deal with the development of framework and prioritization of intellectual capital indicators. A Delphi-AHP-TOPSIS approach is used to solve this kind of problem. In these approach, AHP is used to determine the weight of the attributes and TOPSIS is used to determine the overall ranking of the IC indicators. The main contribution of this study is to develop the theoretical framework of IC indicators and firm performance and to identify their priorities that help the SMEs manufacturing unit by providing a guideline for improving their performance successfully. Based on these priorities, directors of SMEs can portrait their roadmap to allot resources more competently. The weights calculated can help the SMEs manufacturing unit in self-assessments, and constitute a foundation for benchmarking for various activities. IC and firm performance with special focus on SMEs manufacturing unit is an area of interest to various professionals, because India is highly focused on increasing its SMEs contribution to the GDP (Gross domestic product) e.g. managers, shareholders, institutional investors and policy makers. The study is benefitted to SMEs directors who want to determine the possible required changes in the progress of IC in their firm. IC gradually recognized as the major driver of corporate and national growth. In general, prioritizing IC indicators in SMEs manufacturing unit considered vital for comparing different SMEs unit, to approximating their real value, or even to regulatory their improvement year-to-year.

6. Limitation and future work

The sample is representative for Indian managers and directors who are involved in SMEs manufacturing unit located in the central northern part of India. However, the future work done by considering manufacturing industries located in other part of India other than central northern part of India.

References


