Performance assessment of Indian software professionals

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Abstract

Purpose – The purpose of this paper is to develop and validate an instrument/scale to assess the performance of Indian software professionals (SPs).

Design/methodology/approach – Data were collected from 441 software and senior software engineers from eight Indian software firms. The team leaders assessed the performance of software and senior software engineers on 16 items. The software engineers self-reported their experience, need for achievement, and need for social power. The financial performance (FP) of the software firms where the software engineers were working was procured from secondary sources.

Findings – The exploratory and confirmatory factor analyses of scores on 16 items of the instrument suggest six dimensions of performance. They are work-efficiency, personal resourcefulness, inter- and intra-personal sensitivity, productivity orientation, timeliness, and business intelligence. The dimensions have reliability and high convergent validity. SPs having more years of experience, higher need for achievement, and higher need for social power are high performers. The (low) high performing SPs are from firms that have (lower) higher FP.

Practical implications – Human resource managers can evaluate the performance of SPs holistically on six dimensions for training, reward administration, job rotation, and promotion decisions.

Originality/value – This paper develops a behavioural instrument to assess the performance of Indian SPs.

Keywords India, Software engineering, Performance appraisal, Human resource management

Paper type Conceptual paper

1. Introduction

The Indian economy has significantly benefited from software sector. The work of young talented software professionals (SPs) has contributed about 5.4 per cent of the gross domestic product (ASSOCHAM, 2008) in 2006-2007. SPs are those who write code, design programming architecture, look after system networks, manage web pages, and do software maintenance jobs (McConnell, 1998). They not only possess specialized skills and knowledge but also work in lieu of financial rewards and are guided by a code of ethics (Buchholtz, 1989; Kakabadse and Kakabadse, 2000; Mosley and Hurley, 1999).

They are selected on the basis of domain knowledge expertise, inner inclination to do the job, and personality/behavioural attributes. Their cognitive skills are more or less the same because they pass through a series of screening tests of the same difficulty levels. Based on required skills, attributes, and characteristics, this study aims to develop and validate an instrument to evaluate the performance of SPs.

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2. Conceptual background

Assessing the productivity of SPs is an arduous task. There is a large variation in complexity of jobs. The quantity of inputs or outputs of projects can take a month to a year or even more, and in certain instances, several years. Expert SPs can write bug-free programmes on any high-level language that takes lesser microprocessor time as compared to novice SPs. For example, the R&D team of "Microsoft Vista" took eight years to launch their product. Some indirect factors that influence productivity cannot be easily measured, such as management culture, disturbances at work, problems in information flow, lack of competencies required. SPs simultaneously work on many projects and produce different outputs – graphics, expert systems, web traffic control, and maintenance packages – that are difficult to specify in quantity of inputs and outputs (Kemppila and Lonnqvist, 2003).

While some pioneers recommend using kiloline of code per person-months, software theorists prefer to use functional points and programming epithets insist on software reusability and agility. The software development tasks are not fixed, have no production standard time, and can be performed differently by SPs. Productivity assessment is complicated in composing code and debugging software that are unroutinized, unstandardized, and non-deterministic (Ilavarasan and Sharma, 2003). There is no uniform procedure for assessing software productivity that can follow normal distribution pattern for further calibration. Software firms have synonymously used effectiveness, efficiency, quality, innovation, and profitability (Chilton and Hardgrave, 2004; Jackson and Petersson, 1999; Koss and Lewis, 1993; Sink and Tuttle, 1989; Sumanth, 1994; Tangen, 2004; Thomas and Baron, 1994) with productivity that links to SPs' performance. Performance measures productivity indirectly and subjectively (beliefs, perception, and attitude as assessed through questionnaire) when the input and the output information is intangible. The surrogate and subjective productivity evaluated through questionnaire can be gauged for its reliability and validity (Kemppila and Lonnqvist, 2003; Ramirez and Nembhard, 2004; Tangen, 2005; Uusi-Rauva and Hannula, 1996).

Constant schedule pressure, simultaneous work in many projects, chasing deadlines, customers' changing requirements, and demand for new skills and knowledge, continuous code inspections, and sudden offshore assignments keep the SPs under continuous stress (Curtis, 1981; Hatton, 1995; Jett and George, 2003; John *et al.*, 2005; Kanner *et al.*, 1978). At the same time, they are expected to be proactive, flexible, adaptable, share knowledge, and follow professional practices. Despite undergoing stress and increasing expectation, SPs having inner aptitude and behavioural traits can increase their performance. Researchers assert that SPs' performance and project successes depend on their commitment, initiative, leadership, personality, and intrinsic motivation (Baddoo *et al.*, 2006; Boyatzis *et al.*, 2000; Curtis, 1981; Hatton, 1995; Mahalingam, 2001; Rebecca, 2003). Evaluation of these behavioural aspects of SPs through self-rating or superior's rating can assist the "human resource manager" in providing training and education, guiding their careers, redeploying them to new projects, and deciding their promotions. Also, the performance of SPs as an outcome of productivity is studied in more than 50 per cent of articles in work and organizational psychology because in many occupations productivity cannot be directly assessed (Sonnentag and Frese, 2002).

2.2 Performance variables

Performance incorporates skills, attributes, and characteristics that are easy to operationalize. Job performance refers to the degree to which an employee has executed his/her assigned duties. Taxonomical (Ramirez and Nembhard, 2004) and competency

(Turley and Bieman, 1995) studies provide insight on performance dimensions that are listed below.

2.2.1 Timeliness. Delivering the software product and services as promised is timeliness. SPs work on many projects simultaneously that overlap and are clock builders not time-tellers (Collins and Porras, 1994). A reasonable time delay occurs in collecting software artefacts and synchronizing them with the main module. In addition, change in clients' specifications as the project progresses stretches the project completion deadline. A half-baked project even submitted in time summates in reworking. Inability to submit deliverables in time leads to loss of goodwill, adds to opportunity cost, and calls off future projects (Little, 2004).

2.2.2 Autonomy. Evidence suggests that engineers prefer autonomy (Cheney, 1984; Goldstein and Rockart, 1984). Autonomy is the degree to which the job characteristics allow freedom and discretion in the working environment.

2.2.3 Effectiveness. While effectiveness refers to the evaluation of the results of actions, productivity refers to the ratio of output to input. In software projects, effectiveness of SPs depends on doing the job smartly. Effectiveness facilitates the delivery of project outputs in time.

2.2.4 Efficiency. Efficiency is the right way of job execution in a standard time (Ramirez and Nembhard, 2004). Efficient SPs write code in a short time and solve problems of clients by minimizing mistakes. It is the best use of human and material resources at the workplace for the quality output in time. It is the self-assessment against the norms of software process improvement and product development (Herbsleb *et al.*, 1994).

2.2.5 Quality. Quality has multi-level testing methodology including unit test, functional test, integration test, and system test. Quality programmers and design engineers write clear code and translate them into fewer lines of code. Quality as a process assessment of code is measured in terms of bug freeness, syntax proof, functionality, and user satisfaction (DeMarco and Lister, 1985). Artefacts like familiarity of use, shared experience, efficiency, integrity, reliability, usability, accuracy, maintainability, testability, flexibility, reusability, and transferability are quality factors for developers/programmers (Boehm, 1979; McCall *et al.*, 1977). Quality is important for both software developers and customers because poor quality wastes manpower resources, exacts re-work and new work, and increases costs of software projects to a considerable extent.

2.2.6 Customer satisfaction. Software projects of Indian firms provide satisfaction to customers in American and European firms (Cusumano *et al.*, 2003). The product/service delivered according to the wants of customers adds value to them, satisfies them, and increases their loyalty to the product/service provider. Customers giving early feedback can help improve the software product performance by reducing defects.

2.2.7 Profitability. Software projects experience market risk, financial risk, and technical risk (Schwalbe, 2002). A project delivered without cost overrun accounts for profitability. Projects earn profits once the clientele approves the software product being installed and makes successful trial run at the site. Then the profit becomes the revenue for the firm and is shared among employees and investors. The stock value rises and the firm earns the goodwill of employees in stock offer with the profitability. About 70 per cent of the software firms' revenues are spent on personnel-related cost (Khanna and Palepu, 2004) and employees' are given bonus that commensurates with profitability.

2.2.8 Project success. The extent of team members' inter-personal interaction, communication, crisis management, documentation, and transferability of work determines the project success. Feedback received from the customer is a true measure of project success. Both parties should feel satisfied that there are accurate software estimates and deliverables. Completing the project within the budget and meeting customer requirements are hallmarks of project success (Baccarini, 1999; Capers, 1995; Linberg, 1999; Pinto and Slevin, 1988).

2.2.9 Quantity. Quantity refers to mitigation of losses incurred in outputs. It is measured in lines of code written. It goes with right solutions to software problems. Quantity in terms of teamwork is an integral part of collaborative software development.

2.2.10 Responsibility. It is the SPs' accountability under normal and critical times. Role ambiguity remains because SPs have to handle many projects at a time. The responsibilities are fixed on the basis of projects of clients. Responsibility of each team member contributes to a team's responsibility. The entire team is held responsible from inception to delivery and for maintenance of the software.

2.2.11 Team members' cooperation. Members extend their cooperation for a project success. It is determined by the individual's ego-less attitude towards sharing knowledge and expertise as the team demands (Turley and Bieman, 1995). Each software team is constituted on the basis of homogeneous educational background of members for structured work and heterogeneous background of members for unstructured creative work. The extent of cooperation among team members with minimum conflict ensures an active involvement in the project.

2.2.12 Creativity/innovation. Creativity or innovation is the ability to create new ideas to improve upon a product/service (Cusumano and Selby, 1997). Innovation over customer requirements delights the clients (Pavitt, 1990). SPs contribute to the task individually and collectively. The out-of-box thinking comes from SPs having high analytical, reflective, and worldly mindsets.

Based on these dimensions, a scale is developed to assess the SPs' performance. Generally, SPs are evaluated by their superiors. If SPs assess themselves, there is a high chance that they will over evaluate themselves on positive attributes and vice versa. Therefore, the supervisors of SPs can evaluate their subordinates on the above dimensions to avoid over-evaluation on positive attributes (Khuntia and Suar, 2004).

Three primary forms are used to evaluate performance. First, the "behavioural expectation scale" assesses what the rater expects from the ratee. The critical incidents are ordered along a continuum to define outstanding, average, and acceptable performance. Second, the "behavioural observation scale" incorporates the frequency (never to always) with which each behaviour occurs over a period of time. Third, the "behavioural ratings scale" includes the evaluation of employees on each behaviour (very poor to excellent). While the behavioural observation scale assesses the frequency of behaviour, the behavioural rating scale evaluates the quality of behaviour. The behavioural expectation scale takes a longer time to develop and the recency of incidents is likely to taint the evaluation of behaviour in other two scales. No scale is free from bias. Keeping the quality of behaviour to be assessed in the forefront (Chilton and Hardgrave, 2004; Latham and Wexley, 1977; Murphy *et al.*, 1982; Wiersma *et al.*, 1995), a behavioural rating scale/instrument is developed to assess the job performance of SPs.

2.3 Behavioural instrument validation

2.3.1 Experience and SPs' performance. A behavioural rating scale on appraisal of performance of SPs needs validation. First, previous studies have shown that the performance of SPs increases with experience (Turley and Bieman, 1995). The more the experiences of the SPs, the more they know the complexity of software projects and acquire skills to deal with software problems. Hence, the more the experience of the SPs, the better will be their performance.

2.3.2 Motivation and SPs' performance. McClelland's (1994) theory of motivation specifies three needs of motivation:

(1) need for achievement;
(2) need for social power; and
(3) need for affiliation.

Persons having the "need for achievement" have constant desire to do better compared to their past. Their goal is to do the assigned jobs more efficiently and effectively compared to what was done earlier. Persons having high need for achievement prefer to take calculated risks and aspire to accomplish moderately difficult but achievable goals. They take personal responsibility to accomplish the task. They seek constant feedback on how well they are performing the job and have the desire to improve upon past performance.

Need for power is the ability to exert influence on others. The need for power is of two types:

(1) social power; and
(2) personal power.

People having high need for social power are high in self-control and emotional maturity, they cooperate with others and delegate and inspire colleagues to do their jobs. They have a higher level of positive mood that influences programming performance (Judge and Ilies, 2004; Khan *et al.*, 2007). Lord Acton (1987) mentions that "power corrupts, and absolute power corrupts absolutely". Excessive personal power makes a person rude and unkind, exploitative to and unconcerned about others. The "need for affiliation" is the desire to be loved and liked by others. Persons having such need establish relationships with others at the workplace. These people do favour to others depending on the good relationship with them. This need is hardly essential for SPs because they share the project work with others but are independently responsible for performance. In the present study, we propose that high need for achievement and need for social power are likely to positively influence the performance of SPs.

2.3.3 Financial performance (FP) of firms and SPs' performance. Employees are instrumental in managing software projects successfully and bringing profits to firms. Firms where employees' performance is higher will also have a higher FP. Unlike other accounting measures such as return on equity or return on sales that evaluate the FP, return on assets (RoAs) is consistently claimed to be an authentic measure of FP (Berman *et al.*, 1999; McGuire *et al.*, 1988; Venkatraman and Ramanujam, 1986). RoAs is not affected by the differential degree of advantage present in firms. It is positively correlated with the stock price. A higher RoAs implies higher value to stakeholders. Hence, the higher the performance of SPs, the higher will be the FP of the firm in terms of increased RoAs.

The more the experience, the higher the need for achievement, the higher the need for social power of SPs, and the higher the FP of firms where SPs are employed, better would be the performance of SPs. Supporting evidence for this proposition will provide the criterion-related convergent validity to the performance assessment of SPs.

3. Method

3.1 Sample

Performance ratings of 441 SPs were obtained from 55 team leaders of projects. The software engineers having two to three years of service were promoted to senior software engineers based on their performance. The software engineers and senior software engineers were directly reporting to the team leaders about their day-to-day activities. Therefore, the team leader evaluated the performance of SPs.

Data were collected from eight software firms located in IT hubs at Bangalore, Hyderabad, and Kolkata (India), of which four were large size software firms – Infosys Technologies, Tata Consultancy Services Ltd, IBM Computer Ltd, and Microsoft (India) – having more than 15,000 employees and four medium size firms – Accenture Services, Cisco Software, HCL Infosystem, and Siemens Information Systems – having less than 15,000 employees. The lists of engineers were procured from the HR managers. In total, 1,400 software engineers and senior software engineers who had at least two years of experience in the software firm were selected for the questionnaire survey. SPs were contacted through telephone calls and e-mails; 1,313 persons were personally handed over questionnaires and questionnaires were sent to the remaining 83 persons through emails. In total, 371 SPs returned the filled-up questionnaires when the researcher personally approached them and 70 sent the filled-up questionnaires through return e-mails. The return rate was 31.5 per cent.

The salient features of the demographic data obtained in the survey were analysed and two groups (Table I) were compared with F and χ^2 tests. Senior software engineers were older, $F(1, 439) = 146.53$, $p < 0.001$; had more years of formal education, $F(1, 439) = 31.031$, $p < 0.001$; had more years of experience, $F(1, 439) = 124.11$, $p < 0.001$; and had more annual salary, $F(1, 439) = 52.52$, $p < 0.001$, than the software engineers. By and large, senior software engineers and software engineers had nuclear families and did not differ on the family size, $F(1, 439) = 0.94$, $p > 0.05$. There were proportionally fewer female members compared to male members among the software and senior software engineers, $\chi^2(1) = 113.70$, $p < 0.001$. While about equal proportion of the senior software engineers were married $\chi^2(1) = 0.03$, $p > 0.05$, about four-fifths of software engineers were unmarried, $\chi^2(1) = 90.45$, $p < 0.001$.

Variable	Descriptive statistics	Software engineers	Senior software engineers
Age	*M (SD)*	25.54 (1.67)	28.05 (2.63)
Experience	*M (SD)*	2.74 (1.62)	4.87 (2.32)
Annual total salary (in thousands of INR[a])	*M (SD)*	339,000 (111,000)	425,000 (127,000)
Education (years studied)	*M (SD)*	16.29 (0.97)	17.12 (2.16)
Family size	*M (SD)*	4.01 (1.12)	4.13 (1.35)
Gender			
Male	N (%)	243 (80.73)	125 (89.28)
Female	N (%)	58 (19.27)	15 (10.72)
Marital status			
Married	N (%)	68 (22.59)	69 (49.29)
Unmarried	N (%)	233 (77.41)	71 (50.71)

Note: [a]INR = Indian rupees

Table I. Sample profile

3.2 Measures

One questionnaire was administered on SPs incorporating measures of socio-demographic variables on age, education, experience, salary, number of family members along with the need for achievement and need for social power, and another questionnaire was given to team leaders to assess the performance of SPs reporting to them. The secondary data on RoA of software firms where sampled engineers working were collected from CMIE-Prowess database (Prowess, 2005) and from the balance sheet of the companies.

3.2.1 Performance. Based on previous literature (Ramirez and Nembhard, 2004; Turley and Bieman, 1995), 20 items were identified to assess the 12 dimensions of performance of SPs. Three experts, having more than ten years of experience in Indian software firms, were given the questionnaire to evaluate 20 items to assess SPs' performance. Sixteen items agreed by all of them were retained for the final survey. The 16 items (with the attribute) were:

(1) taking decisions (responsibility);
(2) meeting deadlines (timeliness);
(3) independent thinking (autonomy);
(4) working simultaneously on many projects (project success);
(5) mastery of skills and techniques (effectiveness);
(6) conscious for quality (quality);
(7) customer focused (customer satisfaction);
(8) efficient at work (efficiency);
(9) value creation to customer (customer satisfaction);
(10) working overtime (timeliness);
(11) advocating new ideas (innovation);
(12) concern for profitability (profitability);
(13) concerned for quantity (quantity);
(14) taking responsibility (responsibility);
(15) cooperative with team members (team cooperation); and
(16) creativity/innovation (innovation).

Against each item, a ladder was given with ten steps ranging from poor (=0) to excellent (=9). The team leader was asked to rate his/her team members (names provided by the investigator) on the 16 items given in the questionnaire considering the past one-year performance. The items of the scale are given in Table II.

3.2.2 Need for achievement. Four items were developed to measure the "need for achievement". Sample items to measure "need for achievement" include, "I have constant desire to do better compared to past", "I set moderate but achievable goals", "I want a concrete short-term feedback on how well I am performing", and "I do my job to get the inner kick". The response descriptions against each item were given on a five-point Likert-type scale ranging from "strongly disagree" (=0) to "strongly agree" (=4). All items were positively keyed. Using one-factor model of four items, confirmatory factor analysis (CFA) found that the items had good fit ($\chi^2/df = 3.62$, $p < 0.05$,

Table II. Item contents and factor structure for performance

Items[a]	Rotated factor loading						CFA[b]			
							Six factor		One factor	
	I	II	III	IV	V	VI	UNRW[c]	SRW[d]	UNRW	SRW
Mr/Mrs____, a senior/software engineer, …										
(3) Has independent thinking	*0.50*	0.42	0.01	0.02	−0.03	−0.08	0.85	0.45	0.92	0.42
(4) Participates in many projects at a time	*0.71*	0.14	−0.14	0.09	0.24	0.09	1.03	0.54	1.02	0.46
(5) Has mastery of skills and techniques	*0.68*	0.20	0.23	0.21	−0.18	0.00	1.43	0.71	1.33	0.57
(7) Is customer focused	*0.58*	−0.12	0.39	0.06	0.08	0.26	1.00	0.53	1.02	0.47
(8) Is efficient at work	0.21	*0.65*	0.15	−0.19	0.13	0.18	1.00	0.54	0.89	0.45
(9) Creates value to customer	0.20	*0.74*	0.16	0.21	−0.06	−0.02	1.29	0.68	1.17	0.57
(16) Is creative/innovative	−0.07	*0.54*	0.08	0.27	0.33	0.09	0.96	0.48	0.89	0.41
(14) Is responsible at work	0.18	0.06	*0.76*	0.05	0.08	0.12	1.00	0.60	1.00	0.45
(15) Cooperates with team members	−0.07	0.35	*0.73*	0.10	0.04	0.04	1.06	0.62	1.01	0.45
(6) Is quality conscious	0.36	−0.04	0.35	*0.39*	0.32	−0.32	1.00	0.53	0.78	0.42
(10) Works overtime to complete the projects	0.13	−0.07	0.11	*0.73*	0.09	0.07	0.97	0.45	0.75	0.35
(13) Is quantity concerned	0.09	0.34	−0.00	*0.72*	−0.03	0.12	1.16	0.51	1.03	0.46
(1) Takes decisions	0.02	−0.08	0.16	−0.02	*0.71*	0.02	1.00	0.34	0.24	0.17
(2) Meets deadline.	0.06	0.30	−0.07	0.10	*0.71*	0.06	2.68	0.60	0.68	0.32
(11) Advocates ideas to improve product	0.42	0.14	0.05	−0.01	−0.10	*0.70*	1.00	0.60	0.93	0.40
(12) Is concerned about profitability	−0.15	0.04	0.21	0.29	0.27	*0.68*	0.53	0.36	0.63	0.31
Eigenvalues	3.72	1.49	1.24	1.13	1.08	1.01				
Percentage of variance	23.3	9.3	7.8	7.1	6.7	6.3				

Notes: [a]The serial number of the items in the questionnaire is put in parentheses; [b]CFA = confirmatory factor analysis; [c]UNRW = unstandardized regression weight; [d]SRW = standardized regression weight; Italic values indicate significant loadings of items on the factor

CFI = 0.97, GFI = 0.99, NFI = 0.97, RMSEA = 0.078). The Cronbach alpha of four items measuring "need for achievement" on the current sample was 0.65. High additive score on four items indicated high need for achievement.

3.2.3 Need for social power. Four items were developed to assess the "need for social power". Sample items to measure "need for social power" include, "I influence people to change their attitudes", "I try to control people's activities", "I like to be in a position of authority over others", and "I try to persuade my colleagues on work execution". The response descriptions against each item were given on a five-point Likert-type scale ranging from "strongly disagree" (=0) to "strongly agree" (=4). All items were positively keyed. Using one-factor model of four items, CFA found that the items had good fit ($\chi^2/df = 5.36$, $p < 0.01$, CFI = 0.97, GFI = 0.99, NFI = 0.96, RMSEA = 0.095). The Cronbach alpha of four items measuring "need for social power" on the current sample was 0.78. High additive score on four items indicated high need for social power.

3.2.4 Financial performance. From balance sheet of Cisco Software, Accenture Services and Siemens Information System software firms, RoAs were estimated [RoAs = Net profit/Total asset] because their RoAs were not available from the database. For the remaining firms, RoAs were collected from CMIE-Prowess database (Prowess, 2005). The average RoAs from 2004-2005 to 2006-2007 were considered for the software firms. The RoAs were widely apart from one another. Therefore, the firms falling below average RoAs of the sampled firms were coded as "0" and firms falling above the average RoAs were coded as "1".

4. Results

The ratings provided to software engineers and senior software engineers by team leaders were subjected to exploratory factor analysis. The analysis was carried out using SPSS 14.0. Using principal component analysis and considering eigenvalue greater than or equal to one for factor extraction, six factors were extracted that explained 60.42 per cent of the total variance of items. The factors were rotated through varimax procedure (see Table II).

The first factor loaded significantly on four items of "independent thinking", "handling of multiple projects", "mastery of skills and techniques", and "focus on customers". This factor was termed as "work-efficiency". The second factor loaded significantly on three items of "efficient at work", "creating value to customer", and "creativity/innovation" which was named as "personal resourcefulness"'. The third factor loaded on two items of "responsible at work" and "cooperativeness with team members" that was termed as "inter- and intra-personal sensitivity". The fourth factor loaded on three items of "conscious for quality", "working overtime to complete projects", and "concern for quantity", and was termed as "productivity orientation". The fifth factor loaded on two items of "taking decisions" and "meeting deadlines" which was termed as "timeliness". The last factor loaded on two items of "advocating new ideas for improving product" and "showing concern for profitability" which was termed as "business intelligence".

When the scores of items in each factor were added and the scores of these six factors were subjected to second-order factor analysis, only one factor emerged that explained 40.23 per cent of the total variance of six factors. The same factor structure obtained in exploratory factor analysis was retested in CFA using AMOS 4 (Arbuckle and Wothke, 1999). The six factors were interdependent. All the standardized regression weights and unstandardized regression weights on items in the six-factor model were significant. The critical ratio of unstandardized regression weights varied from as low as 3.44, $p < 0.001$ to as high as 8.63. Also, as per the exploratory factor analysis, a parsimonious one-factor model was tested in CFA. All the 16 items of the scale were loaded on a single factor. The unstandardized regression weights were also significant in one-factor model and the critical ratio varied from 3.11, $p < 0.001$ to 7.48.

Because of the sensitivity of chi-square to sample size, the relative chi-square (χ^2/df) was considered. The relative chi-square of six- and one-factor models were not below the cut-off range of 3.0 (Bentler, 1990; Bollen, 1989). Therefore, other fit measures were considered. In both the models, the minimum fit of the model was achieved. The goodness of fit index (GFI) is analogous to squared multiple correlation (R^2) in multiple regression. The comparative fit index (CFI) indicates the overall fit of the model relative to a null model and the normed fit index (NFI) adjusts for the complexity of the model. The GFI was close to 0.90 in both the models. The CFI and the NFI were higher in the six-factor model than on the one-factor model. Root mean square error of approximation (RMSEA) indicates the approximation of the observed model to the true model. The lower the RMSEA, the better the model. RMSEA was within the cut-off value limit of 0.08 in the six-factor model only. The best that could be concluded was that the six-factor model provided a better fit to the data than the rival one-factor specification (Table III).

Each item score correlated significantly with the total score of 16 items suggesting that each item was a definite representative of the measured performance domain of SPs. A technique of item analysis to yield an internally consistent scale was the discriminative power of the item – the ability of an item to separate the "highs" from the "lows". This was estimated by arranging the scores on each item in an ascending order. Scores those falling above the upper quartile (Q_3) and those falling below the lower quartile (Q_1) were compared. When the extreme groups were compared on each item, the *t*-test value indicated high discriminative power of each item. The *t*-values varied from as high as 60.08 to as low as 34.54, $p < 0.001$. Thus, each item of the scale had high discriminative power. The average score of SPs on each of the 16 items was above seven, suggesting that they were high performers (Table IV).

Reliability is the consistency of items and constructs. The reliability of each item was estimated by squaring the standardized factor loading of the item and the composite reliability of each construct (Chilton and Hardgrave, 2004) was estimated as follows:

$$\textit{Composite reliability}\ (CR) = \frac{(\sum\lambda)^2}{(\sum\lambda)^2 + (\sum 1 - \lambda^2)}$$

where λ is the standardized regression weight of an item loading. The composite reliability of 0.60 or greater is desirable for a construct (Bagozzi and Yi, 1988). This composite reliability of a construct is similar to Cronbach's alpha reliability. Out of six factors of the job performance instrument, four had reliability less than 0.60. It was so expected because the items capturing the domains of SPs' performance were not effective

	Fit measure				
Model	χ^2/df	CFI	GFI	NFI	RMSEA
One factor	4.53*	0.67	0.88	0.62	0.09
Six factor	3.92*	0.80	0.92	0.72	0.08

Note: $^*p < 0.001$

Table III. Fit measures of six-factor and one-factor model indicators but causal indicators (Bollen and Lennox, 1991). But, the 16-item scale as a whole had a composite reliability of 0.77 (see Table V).

Validity indicates whether a test measures what it purports to measure. A construct relating to another with which it should hypothetically relate with is called convergent

Table IV. Item analysis

Items	*M*	*SD*	Item-total correlation	Q_1 *M*	Q_1 *SD*	Q_3 *M*	Q_3 *SD*	*t*
Mr/Mrs____, a senior/software engineer, ...								
1. Takes decisions	8.08	0.79	0.22*	7.01	0.52	9.00	0.01	40.49*
2. Meets deadlines	7.85	1.20	0.29*	6.12	0.88	9.00	0.01	34.54*
3. Has independent thinking	7.43	1.25	0.44*	5.69	0.69	8.87	0.33	43.65*
4. Participates in many projects at a time	7.56	1.25	0.43*	5.85	0.80	9.00	0.01	41.18*
5. Has mastery of skills and technique	7.26	1.33	0.52*	5.37	0.50	8.78	0.42	54.75*
6. Is quality conscious	7.59	1.07	0.41*	6.30	0.75	8.93	0.26	34.76*
7. Is customer focused	7.44	1.23	0.47*	5.74	0.70	8.88	0.32	42.78*
8. Is efficient at work	7.47	1.14	0.43*	5.91	0.58	8.77	0.42	41.75*
9. Creates value to customer	7.27	1.17	0.53*	5.63	0.50	8.60	0.49	44.25*
10. Works overtime to complete projects	7.39	1.23	0.40*	5.66	0.61	8.81	0.40	45.40*
11. Advocates new idea to improve product	7.32	1.32	0.44*	5.57	0.52	8.92	0.28	60.08*
12. Is concerned for profitability	7.54	1.17	0.34*	5.96	0.63	8.98	0.13	48.82*
13. Is quantity concerned	7.08	1.29	0.46*	5.42	0.58	8.61	0.49	44.04*
14. Is responsible at work	7.13	1.26	0.45*	5.44	0.50	8.55	0.50	46.19*
15. Is cooperative with team members	7.07	1.29	0.47*	5.49	0.52	8.65	0.48	46.98*
16. Is creative/innovative	7.30	1.24	0.44*	5.66	0.48	8.74	0.44	49.66*
Total	50.8	8.8						

Note: $^{*}p < 0.001$

Table V. Item-reliability and composite reliability

Constructs	Items	Factor loading (λ)	Item reliability (λ^2)	Composite reliability
Work efficiency	Independent thinking	0.50	0.25	0.64
	Handles many projects at a time	0.71	0.51	
	Mastery of skills and techniques	0.68	0.47	
	Customer focused	0.58	0.34	
Personal resourcefulness	Efficient programming skills	0.65	0.42	0.59
	Creates value to the customers	0.74	0.54	
	Creative/innovativeness	0.54	0.29	
Inter- and intra-personal sensitivity	Responsible at work	0.76	0.57	0.54
	Cooperates with the team members	0.73	0.53	
Productivity orientation	Works overtime to complete the project	0.73	0.53	0.50
	Quantity concerned	0.72	0.51	
	Quality conscious	0.39	0.15	
Timeliness	Takes decision	0.71	0.51	0.38
	Meets deadlines	0.71	0.51	
Business intelligence	Advocates new ideas to improve the product	0.70	0.49	0.36
	Concern for profitability	0.68	0.46	
All items				0.77

validity. Six constructs of SPs' performance correlated with the experience, need for achievement, need for social power, and FP of software firms. In accordance with our assumption, more experience in the job increased SPs' performance on all six dimensions. Similarly, with the increase in need for achievement and need for social power, the performance of SPs increased. The software firms having RoAs higher than the average of sampled firms had high performing SPs than software firms having RoAs less than the average (Table VI). These results supported the hypothesis.

In line with the stated objective, the behavioural instrument of performance has six dimensions and these dimensions had reasonable reliability and convergent validity. The items of the scale/instrument had also high discriminative power.

5. Discussion

Collecting data from a cross-section of 441 software engineers and senior software engineers, this study develops a behavioural rating instrument/scale to assess performance of SPs. The team leaders assessed the performance of SPs. SPs self-reported their need for achievement and need for social power, and the FP of the firms was obtained from secondary sources. The factor analysis of 16 items reveals six dimensions of performance. The six dimensions are "work-efficiency", '"personal resourcefulness", "inter- and intra-personal sensitivity", "productivity orientation", "timeliness" and "business intelligence". Each item score correlates highly with the total score and each item has high discriminating power. All items of the scale have high internal consistency. Because of the incorporation of casual indicators to assess the performance, the reliability of four dimensions is below the cut-off level. But, the six dimensions of performance have high convergent validity. With increased years of experience, need for achievement, and need for social power, SPs' performance has improved. Also, the firms that have higher RoAs have high performing SPs compared to the firms that have lower RoAs.

The 16-item instrument to assess performance is reduced to six dimensions. The construct "work-efficiency" focuses on independent thinking, ability to work on various projects simultaneously, programming skills, and customer orientation. "Personal resourcefulness" incorporates the abilities of SPs to be innovative, efficient, and thereby add value to the customer through products and services. The inter- and intra-personal sensitivity shows not only the individual's responsibility at work but also the cooperativeness with the work group to complete the job and deliver the goods. The concern for quantity and quality of software along with overtime work reveal the "productivity orientation". "Timeliness" dimension incorporates taking decision and meeting of deadlines in completing projects. The "business intelligence" is a personal attribute for business sustenance in a competitive environment through advocating new ideas for improving products and services and showing concern for profitability.

All the dimensions reveal the competencies of SPs rather than skills. They include attributes and characteristics that are generic across tasks and situations. These can be well applied to non-routine tasks of SPs. These dimensions contain cognitive and behavioural efforts. As these competencies are generic across contexts, these competencies can be used to gauge the performance of SPs irrespective of the platform in which they work. Work-efficiency, personal resourcefulness, and business intelligence entail intellectual competency, and productivity orientation and timeliness envelope the action-oriented competencies. The inter- and intra-personal sensitivity reveals the affective/emotional competency (Kanungo and Misra, 1992). This indicates that intellectual and action-oriented competencies are more essential to gauge the performance of SPs compared to affective competencies.

Table VI.
Inter-correlations among studied variables

	1	2	3	4	5	6	7	8	9	10
1. Work efficiency	1									
2. Personal resourcefulness	0.37**	1								
3. Inter- and intra-personal sensitivity	0.31**	0.35**	1							
4. Productivity orientation	0.37**	0.34**	0.30**	1						
5. Timeliness	0.16**	0.29**	0.18**	0.23**	1					
6. Business intelligence	0.32**	0.27**	0.28**	0.24**	0.19**	1				
7. Experience	0.19**	0.20**	0.21**	0.24**	0.16**	0.18**	1			
8. Need for achievement	0.20**	0.27**	0.16**	0.26**	0.30**	0.25**	0.29*	1		
9. Need for social power	0.71**	0.66**	0.56**	0.62**	0.49**	0.54**	0.21**	0.82**	1	
10. FP	0.65**	0.55**	0.48**	0.56**	0.23**	0.41**	0.20**	0.58**	0.67**	1
M	29.68	22.04	14.2	22.06	15.92	14.86	3.82	12.21	10.31	0.33
SD	3.49	2.61	2.11	2.54	1.57	1.94	2.57	2.87	3.26	0.47

Notes: $^{*}p < 0.01$; $^{**}p < 0.001$

The instrument has six dimensions and dimension-specific scores can be estimated. The scores of all dimensions can also be added to reveal the overall performance of SPs because the same ratings are used to assess the performance on 16 items of the behavioural rating scale.

To establish the convergent validity of the instrument, experience, need for achievement, need for social power of the SPs, and the FPs of the software firms are related to performance of six dimensions. Here, the findings concur with earlier evidence that more experienced software engineers are found to be better performers than the less experienced (Turley and Bieman, 1995). Experienced software engineers are proactive in performing their jobs/tasks and quickly acquire expertise and knowledge in their jobs. Experienced SPs have faced the complex situations and have learned the nitty-gritties of jobs. They have professional maturity and that is why increased experience has enhanced the job performance of SPs.

Earlier results show that data entry personnel, having high need for achievement, show better performance (Woodruff, 1978). SPs constant desire to do better makes them set moderately difficult but achievable goals for themselves. Our findings also suggest that SPs having high need for achievement are found to be more resourceful, more time-conscious, and more oriented towards productivity. In their jobs, they put constant effort to surpass their competitors. Monetary rewards and career advancement depend on their enduring performance. SPs having higher need for social power influence their colleagues. Their high need for social power increases with work-efficiency, personal resourcefulness, and productivity orientation. SPs having higher need for social power not only influence others but also perform better in their jobs. It is obvious that the better performing employees make high performing organizations. The FP of software firms has improved because SPs have increased their level of performance.

The developed behavioural scale/instrument assesses the quality (very poor to excellent) of behaviour in the context of job performance. The constructs considered here are observer-dependent as well as observer-independent. The positive association of increased performance with observer-dependent measures of high need for achievement, high need for social power and with the observer-independent variables of number of years of experience and FP establishes the criterion-related validity of the instrument.

5.1 Managerial implication of research

Human performance can be measured objectively and subjectively. They are complimentary to one another rather than contradictory (Bommer *et al.*, 1995). While objective measures are criticized to be narrow and focus on lower-order single construct, subjective measures are pleaded to be broad and cover higher-order multiple attributes. Along with the objective measure of performance on kilolines/man-months, the subjective measure of performance developed here can be used to assess the performance of SPs. The developed subjective measure can be used by the HR manager for performance appraisal, training, reward administration, job rotation, and promotion decisions. The annual/bi-annual performance appraisal of SPs would indicate the deficiencies as well as the competencies of SPs in different areas of job performance – work-efficiency, personal resourcefulness, inter- and intra-personal sensitivity, productivity orientation, timeliness, and business intelligence. To compensate the deficiency, training can be provided to upgrade the skill, knowledge, and attitude of SPs. To further the competencies of SPs in specific job domains, intrinsic and extrinsic rewards can be administered. They can be rotated and/or promoted to jobs that can nurture and boost their competencies.

5.2 Limitations

Certain limitations of this study need to be acknowledged. First, the data have been collected from IT hubs at Bangalore, Hyderabad, and Kolkata in India. Therefore, caution must be exercised in generalizing the findings. Second, this study has assessed productivity subjectively through a developed behavioural rating instrument. Though we have developed the questionnaire and refined it, had the questionnaire been developed through critical-incident interviews (Turley and Bieman, 1995), it could be even better. The consistency of the developed instrument can be gauged against objective measures of productivity. Third, the perceptual data obtained through questionnaires might have been contaminated by social desirable responding (SDR). In future research, developing the projective inventories (Puhan, 1995) of constructs used in this study can reduce the SDR. Notwithstanding the limitations, while the data on performance of SPs were collected from team leaders and the data on need for achievement and need for social power were collected from SPs, the data on RoAs were collected from CMIE-Prowess (Prowess, 2005) and the balance sheets of companies. Because the data are collected from various sources to develop the behavioural rating scale/instrument, observed results deem to be free from common method bias (Podsakoff *et al.*, 2003). In addition, this study is the first of its kind to develop and validate a behavioural instrument/scale to assess the performance of Indian SPs.

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