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ENHANCING PERSONNEL SELECTION CRITERIA FOR SOFTWARE PROJECT DEVELOPMENT VIA PROBABILITY MODELING

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Abstract

Over the years, many criteria have existed for selecting and building personnel for software projects, but until now clients continue to get disappointed because of the unsuccessful completion of reliable software products within their expected time frame. Decision makers and software project managers are becoming uncertain and continue to lose confidence in existing personnel selection criteria. In this work, we derive the inclusive criteria set existing in the literature from 1990 to 2019 on software project team formation criteria. We then compute the probability of the incidence of each criterion in order to determine their values over the years. Our result show that the probability that a SPDPSM will be effective in the successful completion of reliable software products within the expected time frame is about 0.877, or 87.7%%, while 12.3% of personnel selection criteria for software project development will be false positive (i.e. will lead to unsuccessful completion of reliable software project development).

1.0 Introduction

The development of high-quality products that meets specifications and that is delivered on time continues to be a major struggle to software companies. There are several stages and existing tools in Software Project Development (SPD). Researchers have shown that to achieve success several factors must come to play. The building and composition of a team are major factors that greatly influence a software project and the overall organizational performance [1,2,3]. The aforementioned must be addressed first because to effectively evaluate team integration we need to identify the personnel selection criteria that are considered in software practice. Resource selection for choosing a best project team at the planning stage of a SDP is an important issue, for failure to do so can manifest in increased project cost, loss of credibility, decrease of service quality, risk and unattainable project deadlines. According to [4] the success or failure of software product mostly depends on the development team.

Team building is the process of taking a set of personnel with different needs, backgrounds and expertise and transforming them by various methods into an integrated, effective work team having a common purpose [5,6]. Research by [7,8] shows that the size of a team plays a significant role during the team composition phase. It is also asserted by [3] that the tasks of a team should be included in a team composition method. Currently, several types of teams have also been identified. Work teams and project teams formation are prerequisite for the development activities that are outsourced continuously or on a project basis, respectively. Furthermore, people from the client company, personnel mediating between the onsite and offshore teams should be included in the team composition.

Several approaches exist for **SPD** personnel selection, they include: Integrated Case-Based Reasoning and AHP method (CB-AHP) [9], Iterative mix techniques (IMT) [10], Data mining approach (DMA), Best-Fitted Resource methodology (BRM) [11], Capabilities-oriented process (COP) [12], Multi-objective genetic algorithm (MGA) and Delphi expert consultation method (DECM). Sometimes the team selection process is undertaken by the project manager who uses personal experience and judgment. Although this approach is prevalent, experimental verification has shown that it does not always yield optimal results [13]. Some other approaches also rely on the professional qualifications and back ground of team members [6,];

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according to [2], a setback in this approach is that project characteristics are often disregarded during the evaluation of potential candidates. Evidence further reveals that the failure of SPD is most often as a result of inadequate human resource development [14,15]. The Successful formation of collaborative teams is still an open problem addressed by on-going research in various fields of business and social studies [16,17].

To estimate a team selection criteria performance probability with a high level of accuracy, we determine what should constitute the exclusive personnel selection criteria (PSC) that should act as a benchmark for determining the formation of a team for a software project. The benefit is that the efficiency rate of the PSC can be determined before deployment and the ratio of accuracy rates to false positives can be analyzed before adoption.

2.0 Software Project Development Personnel Selection Model (SPDPSM)

Most SPDPSM proposed by researchers and experts have unsuccessful address software project development personnel selection issues because these approaches depend on a subset of the entire SPDPSM affecting Software Project Development. For example,

Integrated Case-Based Reasoning and AHP method (CB-AHP) addresses parameters like: time ($T^{CB\text{-}AHP}$), Competence (Ct), Communication ($Co^{CB\text{-}AHP}$) and Risk criticality (R). Mathematically, *CB-AHP* can be defined as the function of four selection criteria (see equation 1), which can be represented as:

$$CB\text{-}AHP = f(T^{CB\text{-}AHP}, Ct, Co^{CB\text{-}AHP}, R) \quad (1)$$

Iterative mix techniques (IMT) have the capabilities to tackle efficiently the following eight parameters: Technical Profile (TP), Personality (P), Behavior (B), Customer Importance (CI), Productivity (Pd), Availability (A), Personnel Cost (PC) and Project Importance (PI). These eight parameters are mathematically represented as shown in equation 2:

$$IMT = f\,(TP, P, B, CI, Pd, A, PC, PI) \quad (2)$$

Data mining approach (DMA) depends on their ability to address effectively, Domain Knowledge Assessment (DKA), Communication skills (Co^{DMA}), Reasoning skills (Rs), General Proficiency performance (GFF), Time efficiency of employee (T^{DMA}) and Performance (P). DMA can be expressed mathematically as (equ. 3):

$$DMA = f(DKA, Co^{DMA}, Rs, GFF, T^{DMA}, P) \quad (3)$$

Best-Fitted Resource methodology (BRM) parameters includes: Task Required Skills (TRS), Skill Relationships (SR), Resources' Skill Set (RSS) and Best-Fitted Resource (BFR). BRM can be expressed as (equ. 4):

$$BRM = f(TRS, SR, RSS, BFR). \quad (4)$$

Capabilities-oriented process (COP) addresses parameters like: Decision making (DC), Analysis (A_{COP}), Independence (I), Innovation/creativity (Inn), Judgement (J), Tenacity (T), Stress Tolerance (ST), Self organization (SO), Risk management (RM), Environmental knowledge (EK), Customer Service (CS), Negotiating Skills (NS), Empathy (Ep), Sociability (Sc), Teamwork/cooperation (TC), Co-worker evaluation (CE), Ground leadership (GL), Planning (Pg) and organization (On). *COP* is defined in equation 5:

$$COP = f(DC, A_{COP}, I, Inn, J, T, ST, SO, RM, EK, CS, NS, Ep, Sc, TC, CE, GL, Pg, On) \quad (5)$$

Multi-objective genetic algorithm (MGA) general competence parameters includes: Analysis (Am), Decision making (Dk), Independence (In), Innovation/creativity (Ic), Judgment (Jd), Tenacity (Tcy), Stress tolerance (Src), Self-organization (Sfg), Risk management (Rmt), Environmental knowledge (Eg), Discipline (Dp), Environmental orientation (Eno), Customer service (Cus), Negotiating skills (Nsk), Empathy (Emp), Sociability (Soc), Teamwork/cooperation (Tmw), Co-worker evaluation (Cw), Group leadership (GP), Planning (Pl), Organization (Ogn) and Professional competences (Pcp). MGA is expressed in equation 6:

$$MGA = f(Am, Dk, In, Ic, Jd, Tcy, Src, Sfg, Rmt, Eg, Dp, Eno, Cus, Nsk, GP, Pl, Ogn, Pcp) \quad (6)$$

Delphi expert consultation method (DECM) have the potential to tackle efficiently the following seven parameters: Professional competences (PC^{DECM}), Project management courses and certifications (Pcc), Group leadership (GL^{DECM}), Domain Knowledge Assessment (DKA^{DECM}), Experience in the use of software development methodologies (Em), Number of successful projects managed (NsP) and Software engineering courses and qualifications (SECQ). DECM can be represented as (equ. 7):

$$DECM = f(PC^{DECM}, Pcc, GL^{DECM}, DKA^{DECM}, Em, NsP, SECQ) \quad (7)$$

3.0 Concept of Exclusivity

To ascertain the best choice of SPDPSM parameters collated from the various literatures that will industriously and inclusively assist in choosing a team, the exclusive parameters are selected by concealing related parameters as is the case with 'Professional competences (Pcp)', 'Task Required Skills (TRS)', 'Competence (Ct)' and 'Professional competences (PC^{DECM})', which will be embedded inside 'Professional competences (PC). Exclusivity concept denoted as *SPx* in this context indicates parameters that are not redefined in every cases of occurrence. Applying the concept of exclusivity in which parameters are uniquely represented, we derive the following thirty-two parameters of equation 8, defined as:

Exclusivity of SPDPSM = SPx(SPDPSM) = f(Co, PC, Sc, RM, TP, J, GL, DKA, Inn, T, NsP, P, A_{COP}*,CE, CS, DC, Ep, EK, I, NS, Pg, SO, ST, T, Dp, P, CI, Pd, A, PC, PI, BFR)* (8)

Where exclusivity *SPx* is with the inference that in all cases of the seven approaches: *CB-AHP*, *IMT*, *DMA*, BRM, COP, MGA and DECM, $Co \equiv Co^{CB\text{-}AHP} \equiv Co^{DMA}$ ≡ TC ≡ Tmw, PC ≡ Pcp ≡ TRS ≡ Ct ≡ PC^{DECM}, Sc ≡ Soc ≡ SR, RM ≡ Rmt ≡ R, TP ≡ GFF ≡ RSS ≡ *Pcc,* J ≡ Rs ≡ Jd, GL ≡ GP ≡ GL^{DECM}, DKA ≡ Eno ≡ DKA^{DECM}, Inn ≡ Ic ≡ Em, $T \equiv T^{CB\text{-}AHP} \equiv T^{DMA}$, NsP ≡ Pd), P ≡ B, A_{COP} ≡ Am, CE ≡ Cw, CS ≡ Cus, DC ≡ Dk, Ep ≡ Emp, EK ≡ Eg, I ≡ In, NS ≡ Nsk, On ≡ Ogn, Pg ≡ Pl, SO ≡ Sfg, ST ≡ Src, T ≡ Tcy, Dp ≡ SECQ

Despite the comprehensive nature of SPx(SPDPSM), it is deficient of four unique parameters that should also add as a measure for an effective authentication model, these are Priorities (P_R), Interests (I_T), Credence (C_D) and Role-Conflict (R_C). We therefore introduce a more inclusive nature of *SPx(SPDPSM)* by introducing EN_{par}, which includes P_R, I_T, C_D and R_C, with a total of 36 parameters as shown in equation 9:

EN_{par} *= f(Co, PC, Sc, RM, TP, J, GL, DKA, Inn, T, NsP, P,* A_{COP}*,CE, CS, DC, Ep, EK, I, NS, Pg, SO, ST, T, Dp, P, CI, Pd, A, PC, PI, BFR,* P_R, I_T, C_D, R_C*)* ... *(9)*

Equation 9 contains the principal parameters that should be evident in any software project development personnel selection model. The drive then is to design more robust models that build on these principal parameters.
Using probability semantics, we next determine the level of efficiency of the individual SPDPSMs under consideration.
Probability of *CB-AHP* is defined as (equ. 10):

$$\mathrm{P}(CB-AHP) = \frac{\text{number of parameters set in } CB-AHP}{\text{number of parameters set in } EN_{par}} = \frac{4}{36} = 0.111, \text{ with efficiency result of 11.1\%} \quad \ldots (10)$$

Similarly,
P*(IMT)* = 0.222, with efficiency result 22.2% (11)
P*(DMA)* = 0.167, with efficiency result 16.7% (12)
P(*BRM*) = 0.111 with efficiency result 11.1% (13)
P(*COP*) = 0.528 with efficiency result 52.8% (14)
P(*MGA*) = 0.5 with efficiency result 50.0% (15)
P(*DECM*) = 0.194 with efficiency result 19.4% (16)

Forming the hybrid SPDPSM systems by deriving the classes of unions of the individual SPDPSM and their corresponding unions based on the exclusivity inference still will not produce systems parameters as robust as that of equations 9. Consequently to increase the efficiency level further for SPDPSMs, we must develop a system that incorporates all 36 parameters, for the effectiveness of EN_{par} is 41.2%improvement over COP, which is one of the most robust existing SPDPSM currently.

4.0 False Positive Effect of SPDPSM Parameter Deficiency

Using Bayes' probabilistic semantics, the effect of a parameter deficiency in any SPDPSM is established to provide evidence of the level of failure that the absence of a parameter can have on the software project team development process.
Where:
X represents the condition, in which a model incorporates P_R, I_T, C_D and R_C
Y represents the evidence of a positive SPDPSM outcome
P(X) = Probability of the SPDPSMs parameter set having P_R, I_T, C_D and R_C = 0.111
P(Y/X) = Probability of an SPDPSM with P_R, I_T, C_D and R_C = P(EN_{par}) = 1.00
P(Y/not X) = Probability of an SPDPSM without P_R, I_T, C_D and R_C = P($ExUn_5$) = 0.889

The probability that a positive result is a false positive is obtained by computing (equ 17 and 18):

$$p\left(\frac{x}{y}\right) = \frac{p\left(\frac{y}{x}\right)p(x)}{p\left(\frac{y}{x}\right)p(x) + p\left(\frac{y}{not\ x}\right)p(not\ x)} \quad (17)$$

$$p\frac{x}{y} = \frac{1.00\ x\ 0.111}{1.00\ x\ 0.111 + 0.889\ x\ 0.889} = \frac{0.111}{0.111 + 0.790321} = 0.123 \quad (18)$$

Hence the probability that a SPDPSM will be effective in the successful completion of reliable software products within the expected time frame is about 1 − 0.123 = 0.877, or 87.7%%, while 12.3% of personnel selection criteria for software project development will be false positive (i.e. will lead to unsuccessful completion of reliable software project development).

5.0 Conclusion

To design effective SPDPSMs, researchers and technologists concentrate on SPDPSM that integrate just a subset of the robust set of SPDPSM parameters. The probabilistic semantics of the different SPDPSM parameters, logically lead to the definitions of key parameters that would enable more enhanced SPDPSM to be developed. Furthermore using Bayes' probabilistic semantics, we were able to provide evidence that the absence of a parameter can affect the efficiency of a SPDPSM in the successful completion of reliable software products within the expected time. A SPDPSM parameterized with these robust set postulated can thus be used for making software project development decisions by applying Bayesian inference.

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