A Novel Approach to Ranking Usability Attributes

K. Paithankar *, Dr. M. Ingle**
*(Department of MCA, Indore Institute of Computer Application, Indore, India)
** (School of Computer Science and Information Technology, DAVV, Indore, India)

ABSTRACT

Usability attributes possess key properties regarding usable software. It has been observed that all the attributes do not implicate similarly in software even though they are equally important for the usability consideration. Therefore, it becomes apparent to determine the ranks of the attributes as they appear in the process of development. In this paper, we propose a novel approach for ranking these usability attributes viz. an algorithmic approach. It is used to compute ranks empirically. There exists various empirical evaluation methods for the study such as controlled experiments, case studies, survey research, ethnographies, action research and mixed-methods used with specific perspective of research problem. We have opted for a pragmatic stance along with its suitable and permitted methods in our proposed work. It would be helpful to improve the usability evaluation process and the overall usability of software as well. Thus, ranking usability attributes will be useful for providing usability measures in software development which may lead to study impact of cost on usable software development process.

Key Words **- Usability, Usability Attributes, Software Project.**

I. INTRODUCTION

Attributes of usability are the important characteristics used to define and obtain usability of software. Also, these attributes play vital role in confirming usability of the developed software [1, 2]. As a vital feature, different views of usability have been represented in terms of a hierarchy or model to represent attributes/ sub-attributes of usability [3, 4, 5, 6, 7, 8]. Each usability attribute influences a typical characteristic associated with software. The impact of each usability attribute may vary during the usability evaluation process. And hence, it is desirable to rank usability attributes that are involved in the software thereby attaining high usability of software. In this scenario, we propose an algorithmic approach for ranking the usability attributes. Each of the usability attributes may contribute equally during software development and usability assessment with different impacts. It is evident that the project parameters dominate the impact of usability attributes in producing usable software [10, 11, 12, 13]. Also, dependencies of usability attributes on parameters instigate to understand their functionality/ behavior in a domain of projects [14, 15, 16, 17, 18, 19]. We review these parameters and present some important terms related to ranking usability attributes in Section II. The proposed algorithm "*CompuRank*" computes ranks of usability attributes and has been discussed in Section III. A case study of the proposed approach is conferred in Section IV. Finally, we conclude with results and discussion along with the usefulness of ranking usability attributes in Section V.

II. TERMINOLOGY

There may exist software projects characterized by some fundamental parameters such as project size, project type and development approach [20]. We define some terms for rank computation such as; software project, level of influence and usability attributes in this Section. Based upon these terms, some new terminology has been presented here.

Software Project

A software project (*SP*) is defined as a set of interrelated tasks executed systematically to produce a software that caters specific need of users. We denote *SP* as a triplet $S_iT_jD_k$, where S_i; i=1, … , p, T_j; j=1, … , q and D_k; k=1, … , r represent project size, project type and project development approach with p, q and r classes respectively [20].

Usability Attributes

A usability attribute possesses the functional characteristic of a usable software and is associated with a software project. Usability attributes are highly concerned with the development of software and may be treated as the means to determine the extent of usability of software [20].

Level of Influence

Level of influence is a qualitative measure of influence of any kind of parameter of a software project $S_iT_jD_k$ on the associated usability attributes. It is denoted by I_m, m=1, … , v; where v denotes the number of levels of influence considered in developing a software project. Each level of influence is mapped quantitatively with weights in such a manner that sum of the weights should be equal to1 [20].

Weight

The magnitude of the influence level of a project parameter on usability attribute is termed as weight of the concerned influence level [20]. Each level of influence is mapped quantitatively with weights in such a manner that sum of the weights should be 1. The weights w_1, w_2, … , w_v may be assigned to levels of influence I_m, m=1, … , v; respectively such that

$$\sum_{i=1}^{v} W_i (I_i) = 1$$

Based upon the fundamental project parameters and aforementioned terminology, we now define some new terms required for ranking usability attributes in algorithmic approach.

We now define some terms based upon aforesaid terms as follows:

Dependency level

A dependency level (*dl*) pertains to the gravity/ degree of dependency of the fundamental parameters on a usability attribute associated with a specified software project. When dependency levels of parameters on usability attributes are assumed to be 0, 1 and 2, it may be signified as the dependency levels independent, partially dependent and highly dependent respectively.

Distinctive Project

It is a type of *SP* defined on specific dependency levels of i[th] kind of project size, j[th] kind of project type and k[th] kind of project development approach used respectively in $S_iT_jD_k$. $S_{idlS}T_{jdlT}D_{kdlD}$ denotes a Distinctive Project (*DP*) if dl_S, dl_T and dl_D are the dependency levels of project size, project type and development approach correspondingly. For example, $S_{20}T_{10}D_{10}$ represents a *DP* of *SP* type $S_2T_1D_1$, based on dependency level 0 of size S_2, type T_1 and development approach D_1.

Dependency Value

Dependency value is the measure of dependency of a usability attribute A_n, n= 1, …, U on project parameters in a *DP*. It is denoted by *DV*. In general, the dependency value of attribute A_n in a *DP* $S_{idlS}T_{jdlT}D_{kdlD}$ is mathematically evaluated as

$$DV(A_n, S_{idlS}T_{jdlT}D_{kdlD}) = WS_{idlS} + WT_{jdlT} + WD_{kdlD} \quad \text{-----}(1)$$

where, WS_{idlS}, WT_{jdlT} and WD_{kdlD} are the weights of level of influence on dependency levels of kinds of *S*, *T* and *D* in a project $S_{idlS}T_{jdlT}D_{kdlD}$. The weights are assigned to the kind of each parameter on their relevant dependency level in a *DP*, whereas assumed to be zero on other dependency levels while computation.

Project Dependency Value

Project dependency value (*PDV*) of an attribute A_n, n=1, ... ,U, represents the overall dependency of A_n pertaining to a *SP*. Mathematically, for each usability attribute A_n in a project $S_iT_jD_k$ it is estimated as

$$DV(A_n, S_iT_jD_k) = \left[\sum_{dl_S=0}^{\ell_1-1} \sum_{dl_T=0}^{\ell_2-1} \sum_{dl_D=0}^{\ell_3-1} DV(A_n, S_{idlS}T_{jdlT}D_{kdlD})\right] / (\ell_1 * \ell_2 * \ell_3) \quad \text{-----}(2)$$

where, $(\ell_1 * \ell_2 * \ell_3)$ is the total number of *DP*s existing with ℓ_1, ℓ_2 and ℓ_3 being the number of dependency levels of *S*, *T* and *D* respectively.

Mean Dependency Value

Mean Dependency Value (*MDV*) of an attribute A_n is the sum of *PDV*s of that attribute in all existing *SP*s. It is also known as impact value of A_n and is computed using equation

$$MDV(A_n) = \left[\sum_{i=1}^{p} \sum_{j=1}^{q} \sum_{k=1}^{r} PDV(A_n, S_iT_jD_k)\right] / p*q*r \quad \text{-----}(3)$$

here, p*q*r is the total number of *SP*s.

III. RANKS OF USABILITY ATTRIBUTES - AN ALGORITHMIC APPROACH

We discuss informal and formal descriptions of the proposed algorithm "*CompuRank*" for computing ranks of usability attributes involved in a variety of projects in this section.

Informal Description

In algorithm, the project parameters are assumed as; project size *S*, project type *T*, project development approach *D* and n usability attributes A_t, t=1, … , n which are to be ranked as 1, … , n . Also, the dependency levels dl_S, dl_T and dl_D are assumed to be associated with parameters *S*, *T* and *D* respectively with their corresponding values as ℓ_1, ℓ_2 and ℓ_3.

Initially, the weights are allocated to influence levels I_m as an input. These weights of influence levels are then assigned to the project parameters for each usability attribute on its pertinent dependency level. Subsequently, *DV*s of each usability attribute A_t in *DP*s, *PDV* of each usability attribute A_t in different *SP*s and *MDV* of each usability attribute A_t in all existing *SP*s are estimated using equations (1), (2) and (3) correspondingly. Finally, ranks are assigned to the attributes on the basis of their respective *MDV*s in such a manner that the attribute with lowest *MDV* will be assigned the highest rank. These are the Suggested Ranks (*SR*) of concerned usability attributes.

Formal Description

Here, we present the formal description of the algorithm "*CompuRank*".

//Algorithm "*CompuRank*"//

// Initialize the counter dest_proj for *DP*s to 0. It is assumed that influence levels of different parameters are assessed prior to input weights. *DV*[], *PDV*[] and *MDV*[] store dependency value, project dependency value and mean dependency value of usability attributes respectively. ℓ_1, ℓ_2 and ℓ_3 are number of dependency levels of project size, type and development approach respectively. WS_{idl_S}, WT_{jdl_T}, WD_{kdl_D} are the weights of influence levels corresponding to *S*, *T*, *D* in *DP*. //

Step 1: //Assign weights corresponding to v number of influence levels $I_1, I_2, \ldots, I_v$ of each kind of parameter *S*, *T*, *D*//

```
Sum=0;
 for i=1 to v
  {
   input (W(I_i));
   Sum=Sum+ W(I_i);
   }
   if Sum ≠ 1 then Display Message "Invalid
        Weights";
```

Step 2: //Input dependency levels of each project parameter *S*, *T* and *D*//

```
input (ℓ1, ℓ2, ℓ3);
```

Step 3: //Input weights corresponding to level of influence of project parameters *S*, *T*, *D* on dependency level associated with each of the n usability attributes //

```
int dl_S, dl_T, dl_D;
for t=1 to n
{
    for i=1 to p
       for j=1 to q
          for k=1 to r;
              {
                for dl_S=0 to ℓ1-1
                  for dl_T=0 to ℓ2-1
                     for dl_D=0 to ℓ3-1
                     {
                     input (WS_idlS);
                     input (WT_jdlT);
                     input (WD_kdlD);
                     }
              }
  }
```

Step-4: //Compute *DV* in *DP*s and *PDV*s in *SP*s for each usability attribute, and hence *MDV* of each usability attribute//

```
dest_proj =1, proj=0, x=1;
for t=1 to n
sum1=0;
 {
  for  i=1 to p
   for  j=1 to q
     for  k=1 to r
       proj=proj+1;
       {
        sum=0;
        for dl_S=0 to ℓ1-1
          for dl_T=0 to ℓ2-1
            for dl_D=0 to ℓ3-1
            {
             DV[t, dest_proj]= S_idlS+WT_jdlT+WD_kdlD;
             sum=sum+ DV[t, dest_proj]
             dest_proj = dest_proj +1;
             }
            PDV[t, proj]=sum/( l1*l2*l3);
            sum1= sum1 +  PDV[t, proj];
            }
          MDV[t]=sum1/( p*q*r);
        }
```

Step-5: //Estimate ranks of usability attributes//

```
int rank=1, SR[], tem;
for t=1 to n
   {
    for  i=t to n-1
     {
      if MDV[t]≥MDV[i+1] then
      {
       tem= MDV[t];
      MDV[t]=MDV[i+1];
      MDV[i+1]=tem;
      }
     }
   SR[t]=rank++;
   }
```

IV. A CASE STUDY

We present a case study for execution of algorithm "*CompuRank*" using twenty four projects. These projects are characterized by the parameters as project size (with its types as small (S_1), intermediate (S_2), medium (S_3) and large (S_4)); project type (with its kinds as organic (T_1), semidetached (T_2) and embedded (T_3)); and developing approach (with its types as procedure oriented approach (D_1) and object oriented approach (D_2)). Each kind of parameter is assigned two dependency levels as 0 (as independent) and 1 (as dependent) on concerned usability attributes. Here, four influence levels have been assumed as insignificant (having weight 0.1), moderate (with weight 0.2), average (holding weight 0.3) and significant influence (possessing weight 0.4). It is used to compute the ranks of some usability attributes associated with these projects. Here, our usability attributes of interest are access control (A_1), adaptability (A_2), affect (A_3), customizability (A_4), efficiency (A_5), helpfulness (A_6), learnability (A_7), operability (A_8), practicability (A_9), resilience (A_{10}), un-ambiguity (A_{11}) and validity (A_{12}). The algorithm *CompuRank* is executed using twenty four projects covering twelve usability attributes. Corresponding to each usability attribute, *PDV*s and *MDV*s have been computed. And, finally the ranks are assigned to each of the usability attributes on the basis of *MDVs* as highlighted with bold blocks in Table-1. In this case, the highest rank is assigned to practicability (A_9); the next higher rank is assigned to operability (A_8) and the lowest rank is assigned to the usability attribute resilience

Table-1: Computation of *MDV*s and *SR*s of Usability Attributes using different Schemes of Weights of Influence Levels

Schemes of Weights of Influence Levels				Attri-butes	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}
$W_1(I_1)$	$W_2(I_2)$	$W_3(I_3)$	$W_4(I_4)$													
0	0.05	0.1	0.85	MDV	0.2063	0.7021	0.2021	0.3417	0.2396	0.6625	0.0688	0.0667	0	1.275	0.3104	0.575
				SR	5	11	4	8	6	10	3	2	1	12	7	9
0	0.05	0.15	0.8	MDV	0.2167	0.6771	0.2083	0.3667	0.2771	0.6542	0.0833	0.0792	0	1.2	0.3104	0.55
				SR	5	11	4	8	6	10	3	2	1	12	7	9
0	0.05	0.2	0.75	MDV	0.2271	0.6521	0.2146	0.3917	0.3146	0.6458	0.0979	0.0917	0	1.125	0.3104	0.525
				SR	5	11	4	8	7	10	3	2	1	12	6	9
0	0.05	0.25	0.7	MDV	0.2375	0.6271	0.2208	0.4167	0.3521	0.6375	0.1125	0.1042	0	1.05	0.3104	0.5
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0	0.05	0.3	0.65	MDV	0.2479	0.6021	0.2271	0.4417	0.3896	0.6292	0.1271	0.1167	0	0.975	0.3104	0.475
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0	0.05	0.35	0.6	MDV	0.2583	0.5771	0.2333	0.4667	0.4271	0.6208	0.1417	0.1292	0	0.9	0.3104	0.45
				SR	5	10	4	9	7	11	3	2	1	12	6	8
0	0.05	0.4	0.55	MDV	0.2688	0.5521	0.2396	0.4917	0.4646	0.6125	0.1563	0.1417	0	0.825	0.3104	0.425
				SR	5	10	4	9	8	11	3	2	1	12	6	7
0	0.05	0.45	0.5	MDV	0.2792	0.5271	0.2458	0.5167	0.5021	0.6042	0.1708	0.1542	0	0.75	0.3104	0.4
				SR	5	10	4	9	8	11	3	2	1	12	6	7
0	0.1	0.15	0.75	MDV	0.2354	0.6375	0.2313	0.3667	0.275	0.625	0.1229	0.1208	0	1.125	0.3292	0.55
				SR	5	11	4	8	6	10	3	2	1	12	7	9
0	0.1	0.2	0.7	MDV	0.2458	0.6125	0.2375	0.3917	0.3125	0.6167	0.1375	0.1333	0	1.05	0.3292	0.525
				SR	5	10	4	8	6	11	3	2	1	12	7	9
0	0.1	0.25	0.65	MDV	0.2563	0.5875	0.2438	0.4167	0.35	0.6083	0.1521	0.1458	0	0.975	0.3292	0.5
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0	0.1	0.3	0.6	MDV	0.2667	0.5625	0.25	0.4417	0.3875	0.6	0.1667	0.1583	0	0.9	0.3292	0.475
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0	0.1	0.35	0.55	MDV	0.2771	0.5375	0.2563	0.4667	0.425	0.5917	0.1813	0.1708	0	0.825	0.3292	0.45
				SR	5	10	4	9	7	11	3	2	1	12	6	8
0	0.1	0.4	0.5	MDV	0.2875	0.5125	0.2625	0.4917	0.4625	0.5833	0.1958	0.1833	0	0.75	0.3292	0.425
				SR	5	10	4	9	8	11	3	2	1	12	6	7
0	0.15	0.2	0.65	MDV	0.2646	0.5729	0.2604	0.3917	0.3104	0.5875	0.1771	0.175	0	0.975	0.3479	0.525
				SR	5	10	4	8	6	11	3	2	1	12	7	9
0	0.15	0.25	0.6	MDV	0.275	0.5479	0.2667	0.4167	0.3479	0.5792	0.1917	0.1875	0	0.9	0.3479	0.5
				SR	5	10	4	8	6	11	3	2	1	12	7	9
0	0.15	0.3	0.55	MDV	0.2854	0.5229	0.2729	0.4417	0.3854	0.5708	0.2063	0.2	0	0.825	0.3479	0.475
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0	0.15	0.35	0.5	MDV	0.2958	0.4979	0.2792	0.4667	0.4229	0.5625	0.2208	0.2125	0	0.75	0.3479	0.45
				SR	5	10	4	9	7	11	3	2	1	12	6	8
0	0.15	0.4	0.45	MDV	0.3063	0.4729	0.2854	0.4917	0.4604	0.5542	0.2354	0.225	0	0.675	0.3479	0.425
				SR	5	9	4	10	8	11	3	2	1	12	6	7
0	0.2	0.25	0.55	MDV	0.2938	0.5083	0.2896	0.4167	0.3458	0.55	0.2313	0.2292	0	0.825	0.3667	0.5
				SR	5	10	4	8	6	11	3	2	1	12	7	9
0	0.2	0.3	0.5	MDV	0.3042	0.4833	0.2958	0.4417	0.3833	0.5417	0.2458	0.2417	0	0.75	0.3667	0.475
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0	0.2	0.35	0.45	MDV	0.3146	0.4583	0.3021	0.4667	0.4208	0.5333	0.2604	0.2542	0	0.675	0.3667	0.45
				SR	5	9	4	10	7	11	3	2	1	12	6	8
0	0.25	0.3	0.45	MDV	0.3229	0.4438	0.3188	0.4417	0.3813	0.5125	0.2854	0.2833	0	0.675	0.3854	0.475
				SR	5	9	4	8	6	11	3	2	1	12	7	10
0	0.25	0.35	0.4	MDV	0.3333	0.4188	0.325	0.4667	0.4188	0.5042	0.3	0.2958	0	0.6	0.3854	0.45
				SR	5	7	4	10	8	11	3	2	1	12	6	9
0.05	0.1	0.15	0.7	MDV	0.2479	0.6188	0.2438	0.3583	0.2813	0.5958	0.1438	0.1417	0.075	1.05	0.3271	0.525
				SR	5	11	4	8	6	10	3	2	1	12	7	9
0.05	0.1	0.2	0.65	MDV	0.2583	0.5938	0.25	0.3833	0.3188	0.5875	0.1583	0.1542	0.075	0.975	0.3271	0.5
				SR	5	11	4	8	6	10	3	2	1	12	7	9
0.05	0.1	0.25	0.6	MDV	0.2688	0.5688	0.2563	0.4083	0.3563	0.5792	0.1729	0.1667	0.075	0.9	0.3271	0.475
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0.05	0.1	0.3	0.55	MDV	0.2792	0.5438	0.2625	0.4333	0.3938	0.5708	0.1875	0.1792	0.075	0.825	0.3271	0.45
				SR	5	10	4	8	7	11	3	2	1	12	6	9
0.05	0.1	0.35	0.5	MDV	0.2896	0.5188	0.2688	0.4583	0.4313	0.5625	0.2021	0.1917	0.075	0.75	0.3271	0.425
				SR	5	10	4	9	8	11	3	2	1	12	6	7
0.05	0.1	0.4	0.45	MDV	0.3	0.4938	0.275	0.4833	0.4688	0.5542	0.2167	0.2042	0.075	0.675	0.3271	0.4
				SR	5	10	4	9	8	11	3	2	1	12	6	7
0.05	0.15	0.2	0.6	MDV	0.2771	0.5542	0.2729	0.3833	0.3167	0.5583	0.1979	0.1958	0.075	0.9	0.3458	0.5
				SR	5	10	4	8	6	11	3	2	1	12	7	9
0.05	0.15	0.25	0.55	MDV	0.2875	0.5292	0.2792	0.4083	0.3542	0.55	0.2125	0.2083	0.075	0.825	0.3458	0.475
				SR	5	10	4	8	7	11	3	2	1	12	6	9

				MDV	0.2979	0.5042	0.2854	0.4333	0.3917	0.5417	0.2271	0.2208	0.075	0.75	0.3458	0.45
0.05	0.15	0.3	0.55	SR	5	10	4	8	7	11	3	2	1	12	6	9
				MDV	0.3083	0.4792	0.2917	0.4583	0.4292	0.5333	0.2417	0.2333	0.075	0.675	0.3458	0.425
0.05	0.15	0.35	0.45	SR	5	10	4	9	8	11	3	2	1	12	6	7
				MDV	0.3063	0.4896	0.3021	0.4083	0.3521	0.5208	0.2521	0.25	0.075	0.75	0.3646	0.475
0.05	0.2	0.25	0.5	SR	5	10	4	8	6	11	3	2	1	12	7	9
				MDV	0.3167	0.4646	0.3083	0.4333	0.3896	0.5125	0.2667	0.2625	0.075	0.675	0.3646	0.45
0.05	0.2	0.3	0.45	SR	5	10	4	8	7	11	3	2	1	12	6	9
				MDV	0.3271	0.4396	0.3146	0.4583	0.4271	0.5042	0.2813	0.275	0.075	0.6	0.3646	0.425
0.05	0.2	0.35	0.4	SR	5	9	4	10	8	11	3	2	1	12	6	7
				MDV	0.3354	0.425	0.3313	0.4333	0.3875	0.4833	0.3063	0.3042	0.075	0.6	0.3833	0.45
0.05	0.25	0.3	0.4	SR	5	8	4	9	7	11	3	2	1	12	6	10
				MDV	0.2896	0.5354	0.2854	0.375	0.3229	0.5292	0.2188	0.2167	0.15	0.825	0.3438	0.475
0.1	0.15	0.2	0.55	SR	5	11	4	8	6	10	3	2	1	12	7	9
				MDV	0.3	0.5104	0.2917	0.4	0.3604	0.5208	0.2333	0.2292	0.15	0.75	0.3438	0.45
0.1	0.15	0.25	0.5	SR	5	10	4	8	7	11	3	2	1	12	6	9
				MDV	0.3104	0.4854	0.2979	0.425	0.3979	0.5125	0.2479	0.2417	0.15	0.675	0.3438	0.425
0.1	0.15	0.3	0.45	SR	5	10	4	8	7	11	3	2	1	12	6	9
				MDV	0.3208	0.4604	0.3042	0.45	0.4354	0.5042	0.2625	0.2542	0.15	0.6	0.3438	0.4
0.1	0.15	0.35	0.4	SR	5	10	4	9	8	11	3	2	1	12	6	7
				MDV	0.3188	0.4708	0.3146	0.4	0.3583	0.4917	0.2729	0.2708	0.15	0.675	0.3625	0.45
0.1	0.2	0.25	0.45	SR	5	10	4	8	6	11	3	2	1	12	7	9
				MDV	0.3292	0.4458	0.3208	0.425	0.3958	0.4833	0.2875	0.2833	0.15	0.6	0.3625	0.425
0.1	0.2	0.3	0.4	SR	5	10	4	8	7	11	3	2	1	12	6	9
				MDV	0.3479	0.4063	0.3438	0.425	0.3938	0.4542	0.3271	0.325	0.15	0.525	0.3813	0.425
0.1	0.25	0.3	0.35	SR	5	8	4	9	7	11	3	2	1	12	6	10
				MDV	0.3313	0.4521	0.3271	0.3917	0.3646	0.4625	0.2938	0.2917	0.225	0.6	0.3604	0.425
0.15	0.2	0.25	0.4	SR	5	10	4	8	7	11	3	2	1	12	6	9
				MDV	0.3417	0.4271	0.3333	0.4167	0.4021	0.4542	0.3083	0.3042	0.225	0.525	0.3604	0.4
0.15	0.2	0.3	0.35	SR	5	10	4	9	8	11	3	2	1	12	6	7

(A_{10}), meaning that the attribute having lowest value of *MDV* has assigned the highest rank whereas the lowest rank is assigned to the usability attribute possessing the highest value of corresponding *MDV*. Thus, practicability shows its precedence over the other usability attributes. Similarly, we have exercised the algorithm on forty seven schemes of weights of influence levels to compute ranks of usability attributes as shown in Table-1.

V. RESULTS AND DISCUSSION

Based on the outcomes generated through the proposed novel approach for ranking usability attributes, we perceive the following observations:

(i) With all schemes of weights, practicability attains highest rank (i.e. 1) whereas resilience obtains lowest rank (i.e. 12). It has been observed that computed rank of attributes practicability (rank 1), operability (rank 2), learnability (rank 3), affect (rank 4), access control (rank 5), and resilience (rank 12) remains unchanged with all schemes of weights whereas the computed ranks of un-ambiguity, efficiency, customizability, validity and adaptability are jerky within ranks 6 to 10. Though the rank of attribute helpfulness (rank 11) remains consistent with majority of the schemes, variation has been observed in some cases (obtained rank is 10). In general, it means that the usability attributes with varying ranks poses dynamic impact during software development whereas the attributes having consistent ranks prove their existence equally during software development process.

(ii) Altogether, the variation in *SR*s of usability attributes is observed due to the weights assigned to the influence levels of parameters on these attributes. Significant variation in weights of significant and average influence levels has higher probability of varying ranks of corresponding usability attribute. As per the weights assigned (lower/ higher) to these influence levels, the rank of usability attribute is either upgraded or degraded and a different set of ranks is obtained as a result.

(iii) *MDV* is the representative of cumulative influence of project parameters on usability attribute as higher *MDV* represents higher dependency of an attribute on project parameters. Assigning higher values to insignificant, moderate and average influence levels contradict the basic dependency definitions of usability attributes and thus avoided. Based on the *MDV*s, there may be conflict while ranking usability attributes when more than one attributes are the candidates for the same rank. This may be resolved by assigning them distinct ranks in alphabetical order.

(iv) Using "*CompuRank*", it is possible to prioritize usability attributes in a generalized and structured manner. At present, it deals with three project parameters such as; project size, project type and project development approach used. Moreover, it may be further generalized for ranking usability attributes with any number and kinds of parameters. It may also be concluded that any scheme of weights may be used as per the requirement to rank usability attributes.

VI. CONCLUSION

The proposed work primarily focuses on computing ranks of usability attributes. This novel approach viz. algorithmic approach is using the empirical methods for the intended purpose. Here, the concurrent triangulation strategy of mixed-methods has been adopted for the reason that we have associated such an empirical method with the approach which effectively addresses the problem.

Ranking usability attributes will be of great support to developers while software development and will be helpful for usability evaluation as well. Inclusion of these ranks during software development in turn will be useful to characterize and attain usable software.

Ranking usability attributes will lead to provide help for assessment of various aspects related to usability such as; generating usability metric, to provide measures of usability during software development and even for investigating impact of cost on usable software development at the same time.

REFERENCES

[1] Paithankar, K. and Ingle, M., *Reviewing Software Quality Attributes Classification in Perspective of Usability*, PCTE journal of computer Science, Volume 7, Issue 1, January-June, 2010, pp 107-117.

[2] Khosravi , K. and Yann-Ga¨el Gu´eh´eneuc, *On Issues with Software Quality Model*, Group of Open and Distributed Systems, Experimental Software Engineering Department of Informatics and Operations Research University of Montreal, Quebec, Canada, pp 70-83.

[3] Nielsen, J., *Usability engineering*, Boston Academic Press, 1993.

[4] Nielsen, J., *Usability engineering life cycle*, IEEE computer society, Volume 25, Issue 3, March, 1992, pp 12-22.

[5] Nigel, B, and Motoei, A., *Quality in Use: Incorporating Human Factors into the software life cycle*, Third IEEE International Software Engineering Standards Symposium and Forum default weight 'Emerging International Standards', ISESS 97 Publication, June1-6, 1997, pp 169-179.

[6] Andreas, Lecerof and Fabio, Paternò, *Automatic Support for Usability Evaluation***.** IEEE transactions on software engineering, Volume 24, Issue 10, October 1998, pp 863-888.

[7] Granic, A. Glavinic, V., *Usability Evaluation Issues for Computerized Educational Systems*, Eleventh Mediterranean Electro Technical Conference, MELECON, 2002, pp 558- 562.

[8] Kurosu, M.; Kashimura, K., *Determinants of the Apparent Usability*, IEEE International Conference on Systems, Man and Cybernetics, Intelligent Systems for the 21st Century, Volume 2, October 22-25, 1995, pp 1509-1514.

[9] Easterbrook, S.; Singer, J.; Storey, M. and Damin, D., *Selecting Empirical Methods for Software Engineering Research*.

[10] Paithankar, K. and Ingle, M., *Characterization of Software Projects by Restructuring Parameters for Usability Evaluation*, Second International Conference on Computer and Electrical Engineering (ICCEE 2009), Dubai, UAE, December 28-30, 2009, pp 438-443.

[11] Yourdon, Ed, *Software Metrics*, Application Development Strategies, Volume 6, Issue 11, November 1994, pp1-16.

[12] Fenton, N., *Software Measurement: A necessary Scientific Basis*, IEEE Transactions of Software Engineering, Volume 20, Issue 3, March 1994, pp 199-206.

[13] Adikari, S. M. C., *User and Usability Modeling for HCI*, International Conference on Information and Automation, ICIA 2006, December 15-17, 2006, pp 151-154.

[14] Peter J. Haas, Fabian Hueske, Volker Markl, Detecting Attribute Dependencies from Query Feedback, 33rd international conference on Very large data bases, Austria, 2007, pp 830-841.

[15] Parvinder S. Sandhu, Pavel Blecharz and Hardeep Singh, *A Taguchi Approach to Investigate Impact of Factors for Reusability of Software Components*,Journal of World Academy Of Science, Engineering And Technology, Volume 25, 2007, pp 135-140.

[16] Bernhard Peischl, Mihai Nica, Markus Zanker, *Recommending effort estimation methods for software project management*, IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology, Volume 03, 2009, pp 77-80.

[17] Zhizhong Jiang, Peter Naudé, and Binghua Jiang, *The Effects of Software Size on Development Effort and Software Quality*, World Academy of Science, Engineering and Technology, Volume 34, 2007, pp 31-35.

[18] Mikhail Perepletchikov, Caspar Ryan, and Zahir Tari, *The Impact of Software Development Strategies on Project and Structural Software Attributes in SOA*, On the Move to Meaningful Internet Systems 2005: OTM Workshops, Cyprus, October 11, 2005.

[19] Hein, Aucamp, *Software Quality and Influence of Size*, AOQ Presentation, November 25, 2004.

[20] Paithankar, K. and Ingle, M., *Influence of Parameters on Usability Attributes in Software Projects*, International Conference on Advances in Software Engineering and Information Technology, ICASEIT 2011, Malaysia, January 14-15, 2011, pp 268-272.