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Exploring the Structure of Volunteer Activities in Hospital Settings Using Multidimensional Scaling: A Preliminary Study

Abstract: *As the Thai people have been more aware of the importance of volunteering, the structure of volunteer activities in the country's hospitals has become more complicated. As a result, medical personnel and volunteer organizations have faced challenges in connecting people with the activities most relevant to concerns and needs. In order to assist the host parties as well as individual volunteers, a system that can match the personal characteristics of volunteers to the demands of the activities needs to be developed. As a starting point, multidimensional scaling was used in this study to reveal a working structure for volunteer activities by exploring major dimensions underlying the similarity and dissimilarity between these activities. Twenty-three volunteer activities proposed by a panel of experts and stakeholders were subject to an ordinal (non-metric) multidimensional scaling. All but one volunteer activity can be grouped along three dimensions:* hospital-related, lecturing versus group leading, *and* empathic communication. *These three dimensions can serve as a blueprint for identifying personal characteristics that may be essential to each activity and for designing a system for volunteer recruitment and placement.*

Keywords: *volunteers, multidimensional scaling, placement, job analysis, hospital settings*

EXPLORING THE STRUCTURE OF VOLUNTEER ACTIVITIES IN HOSPITAL SETTINGS USING MULTIDIMENSIONAL SCALING

As volunteer activities in hospital settings seem to have evolved over time and call for a new range of skills, abilities, and psychological attributes, a proper procedure to pair prospective volunteers with appropriate activities to maximize the fit between activity demands and their individual qualifications needs to be developed. In the past, for example, medical personnel and volunteer organizations tended to assign prospective volunteer positions by merely asking what activities they wanted to perform (i.e., self-report motivation), not by determining the activities they were most qualified to do (e.g., knowledge, skills, and other attributes). It is clear that motivation is an important factor for volunteer activity choice and performance. However, as the number of activities continues to grow and the structure of these activities is more complicated, other factors besides motivation need to be considered to create a system that can combine a huge amount of information into a single platform to help medical personnel, as well as volunteer organizations, make better decisions. In order to create such a system, we need to have a clearer picture of the complexity of distinct activities as well as a sound instrument to assess the personal characteristics of volunteers. Borrowing from personnel psychology, task or job analysis would be a good starting point for the former (or more recently work analysis; Sanchez & Levine, 2012), and an array of psychological measures (e.g., cognitive ability test or personality assessment; Schmitt, 2014) are available to assess the latter.

Borrowing an idea from Landis, Fogli, and Goldberg (1998), a list of 23 volunteer activities was created from

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a future-oriented perspective by a panel of medical professionals and volunteer veterans who have had lengthy volunteer experiences in hospital settings. Some activities are currently in operation while others will hopefully begin in the near future. Nevertheless, the challenge of carrying out a job analysis for these activities is that information from incumbents for some activities is unattainable and that the stakeholders may not have a clear picture regarding the nature of novel activities. Hence, as a starting point, we needed to develop a sketch of the activity structure in order to understand the dimensionality underlying the demands of the activities as well as what personal characteristics (i.e., KSAOs) required for each activity. One efficient method to facilitate our understanding of the activity structure was to ask stakeholders to judge the similarity and dissimilarity between volunteer activities and use a multidimensional scaling technique to extract hidden dimensions that may be useful for designing a volunteer placement system.

Multidimensional scaling has been shown to be useful in terms of job analysis. Some scholars and practitioners have utilized this technique to examine judgments pertaining to the similarity between job units in order to gain insight into fundamental dimensions on which job incumbents and experts based their judgments. For example, Brown (1967) asked job incumbents to rate (on a seven-point scale) the similarity of 18 behavioral statements describing interpersonal relation tasks for the position of management analysts. A multidimensional scaling technique was employed to explore the underlying dimensions. Brown's analysis indicated the existence of the following five dimensions: (i) tact in personal contacts, (ii) accepting others' viewpoints, (iii) information collection, (iv) verbal persuasiveness, and (v) controlling people through consideration. In addition, Smith and Siegel (1967) performed a multidimensional scaling analysis to explore the dimensions underlying a constellation of 34 civil defense director jobs. Thirty-five respondents were asked to rate the similarity between each pair of the jobs by using an 11-point scale ranging from very similar to very different. The results revealed three clear dimensions: internal versus external system maintenance, routine versus emergency programming, and resource use versus resource evaluation plus one less apparent, unipolar dimension (i.e., emergency system integration). The configuration distances indicated where each job was on the dimension continuums. Smith and Siegel noted that the dimensions extracted could be used as a foundation for personnel planning (e.g., selection and development) as well as performance evaluation.

One obstacle to using multidimensional scaling for job analysis, and the assessment of organizations in general, is that when the number of objects is large, respondents have to devote a substantial amount of time engaged in the comparison task. For example, if there are 15 objects, respondents have to compare the similarity of 120 pairs of objects, and the number of paired comparisons increases exponentially when only a few more objects are included. Moreover, when the similarity between two objects was not scored using a ratio scale, a requirement to perform multidimensional scaling in the past, one needs to make a correction by adding a constant to the original scores (see Smith & Siegel, 1967). Fortunately, multidimensional scaling procedures have evolved in many aspects during the past years, and two aspects were related to the aforementioned problems. First, in order to score the dissimilarity between objects, a holistic approach has gained popularity. Tsogo, Masson, and Bardot (2000) reviewed various approaches to rating dissimilarity and encoding scores from a large pool of objects such as using incomplete pair comparisons or sorting objects. Importantly, the authors suggested that sorting and ranking objects, combined with multiple respondents, are most appropriate when one needs a complete dissimilarity matrix as an input for multidimensional scaling, as is the case with the present study. Hence, we decided to use an adapted version of a hierarchical sorting task (Rao & Katz, 1971) as an approach to scoring and constructing a dissimilarity matrix. Second, there is no need to correct or rescale dissimilarity scores to obtain a ratio property because nonmetric multidimensional scaling procedures for dissimilarity scores on an ordinal scale have been developed and tested (Jacoby & Ciuk, 2018) as well as a corresponding user-friendly statistical package (Mair, 2018).

In the present study, multidimensional scaling was chosen as a suitable technique to re-model the volunteer placement system. This approach seemed especially relevant given that some volunteer activities were newly created and not fully operational. As multidimensional scaling has been underutilized in psychological research despite its usefulness and flexibility in analyzing similarity data, we employed this technique to uncover the underlying structure of volunteer activities in hospital settings and, hopefully, to demonstrate the advantage and practicality offered by this technique. The projected outcomes of multidimensional scaling for this study were two-fold. First, we expected that a small number of meaningful dimensions would emerge to capture volunteer activities. Second, we anticipated that these activities could be grouped according to such dimensions. The dimensions and activity groupings would allow us to better conceptualize the structure of volunteer activities and to design a body of psychological measures to match prospective volunteers to particular activities.

The current study is exploratory in nature. We did not have a concrete hypothesis regarding the number of dimensions (as well as the underlying features) that would materialize from the analysis. However, multidimensional scaling typically extracts only a few dimensions (rarely more than three; Jacoby & Ciuk, 2018). Volunteer activities in hospital settings commonly involve guiding patients from registration to payment, which can require volunteers to deal with their emotions. Consequently, we expected a minimum of two dimensions to arise from the analysis: familiarity with hospital settings and a demand to deal emotionally with frustrating and confusing patients.

METHODS

Participants

Participants were 30 individuals (i.e., four medical doctors, five veteran volunteers, and 21 nurses and other veteran volunteers; however, due to limitation of data accessibility, we could not provide the breakdown of 21 participants) from one large public hospital located in Bangkok, Thailand. They were more females (n = 21; 70%) than males (n = 9; 30%), with an average age of 39.3 years (SD = 12.2). All participants obtained a minimum of one-year working experience in the hospital to ensure the basic knowledge and structure of the organization.

Procedures

As part of a half-day workshop conducted on July 2018 to gather opinions about newly-developed volunteer activities in the hospital, a data collection session was pre-arranged for 45 minutes at the end of the workshop. Participants were split into four groups (for the sake of convenience only), each of which had seven to eight individuals. A workshop instructor presented a pool of 23 volunteer activities, which were derived from the previous workshop and then introduced the direction and details of how to construct a response by considering the similarity between volunteer activities (as described in the next section). Subsequently, trained workshop assistants were assigned to each group (two per group) to clarify and facilitate the response process. Respondents were informed that there were no right or wrong answers, and their responses were anonymous. That is, no personal identifiers or demographic information were attached to the responses. The demographic information of participants was drawn from the workshop organizer.

Measures

A list of 23 volunteer activities was provided. Activity examples were *to provide information about patients' rights*, *to provide information about where to go and what to do when visiting the hospital*, and *to provide basic knowledge on how to take care of ones' own mental and physical health* (see Table 1 for the full list). This list was a part of the needs assessment workshop for future volunteering work, which was conducted among medical staff, veteran volunteers, and hospital administrative personnel (of these, nine individuals were participating in this study). Almost a hundred volunteer activities were proposed in the brainstorming session and were shortlisted to 23 activities in subsequent sessions. For the process of how participants judged the similarity between activities, we adopted a hierarchical sorting task proposed by Rao and Katz (1971) and adapted it to be more flexible in terms of sorting and scoring. Specifically, a response process was comprised of two steps. First, participants were instructed to group these 23 activities into six-to-eight subsets based on their perceived similarity. Specifically, they were asked to group the most similar activities into a subset. The number of subsets presents a trade-off between sensitivity (or precision as stated in the original paper; Rao & Katz, 1971) and errors (i.e., the greater the number of subsets, the more sensitivity in judging the similarity between objects, but the more the errors potentially made in responding). Therefore, we thought that restricting the number of subsets within a range of six to eight would give participants sufficient room for making distinctions between activities but not too much to induce confusion in assigning each activity into a group.

Next, participants were asked to arrange these subsets into a small network by making subsets as a node and connecting two related nodes by an edge. Two subsets that seemed to share some characteristics were linked to each other. The lesser similarity between the subsets (i.e., having fewer things in common), the further these subsets were located apart (with the greater number of edges). For each participant, we then turned the network arrangement into dissimilarity scores for each pair of activities by coding a score between the activities in the same subset as "1" and that between the activities in different subsets as "1" plus the number of edges. For instance, if one activity was located two edges apart from another activity, the dissimilarity score between these activities was "3" ("1" plus "2"). We used dissimilarity scores averaged from all participants as an input for a multidimensional scaling analysis.

RESULTS

Using the *smacof* package (Mair, Leeuw, & Groenen, 2015) in the R environment (R Core Team, 2015), an ordinal multidimensional scaling analysis indicated that the volunteer activities may meaningfully lie on a three-dimensional space, with small discrepancies between dissimilarity scores and configuration distances being observed. In order to examine the goodness of fit, we used the results from a Shepard diagram and a comparison between an actual stress value and an average of 1,000 permutated stress values. As a result, the Shepard diagram showed that the coordinates between dissimilarity scores and configuration distances crowded together diagonally from lower-left to upper-right of the graph, not far from the monotonically transformed disparities, indicating a good fit of the solution. Moreover, we computed 1,000 permutated stress values and constructed a 95% confidence interval in order to examine if an actual stress value was less than the 2.5 percentile. When comparing to the distribution of the permutated stress values, the actual stress value was 0.03 which was less than the 2.5 percentile. Therefore, both the Shepard diagram and the stress value supported that the three-dimensional solution was a proper outcome. We then concluded that the solution was adequate in explaining the dissimilarity between volunteer activities.

Next, all the activities were arranged by their configuration distances in each dimension from the highest to the lowest in order to figure out the feature of each dimension. Table 1 displays configuration distances for each dimension. For the first dimension, there were activities related to locations and procedures in hospital

Table 1

Configuration Distances of the Volunteer Activities in a Three-dimensional Space

Dimension 1		Dimension 2		Dimension 3	
Volunteer Activity	**CD**	**Volunteer Activity**	**CD**	**Volunteer Activity**	**CD**
Helping new patients	0.82	Leading group conversation	0.57	Educating patients about (assistive) technology devices	0.33
Taking patients from stations to stations in a hospital	0.80	Designing jobs for the elderly	0.53	Educating patients about law	0.28
Facilitating a registration process	0.76	Leading group gaming sessions	0.52	Leading group gaming sessions	0.23
Preparing medical equipment	0.65	Leading group music sessions	0.47	Facilitating handicraft activities	0.22
Providing information about hospital sites	0.58	Leading group art sessions	0.47	Leading group music sessions	0.21
Providing information about medical services	0.58	Facilitating handicraft activities	0.45	Leading group art sessions	0.21
Facilitating handicraft activities	0.48	Facilitating a registration process	0.31	Educating patients about how to manage their surroundings	0.14
Providing information about insurance reimbursement	0.43	Taking patients from stations to stations in a hospital	0.30	Leading group conversation	0.13
Providing information about patients' right	0.39	Helping new patients	0.26	Providing information about hospital sites	0.09
Health education	-0.06	Managing an advance care planning meeting	0.02	Educating (elderly) patients about life after retirement	0.08
Educating patients about (assistive) technology devices	-0.17	Providing information about hospital sites	-0.10	Health education	0.07
Educating patients about how to manage their surroundings	-0.17	Preparing medical equipment	-0.12	Providing information about medical services	0.07
Educating patients about law	-0.21	Family counseling	-0.16	Educating patients about self-care providing	0.04
Educating patients about self-care providing	-0.21	Providing information about medical services	-0.17	Providing information about insurance reimbursement	0.03
Educating (elderly) patients about life after retirement	-0.38	Providing information about insurance reimbursement	-0.22	Helping new patients	0.03
Leading group conversation	-0.40	Individual counseling	-0.24	Providing information about patients' right	0.02
Leading group gaming sessions	-0.50	Providing information about patients' right	-0.27	Facilitating a registration process	0.01
Leading group music sessions	-0.54	Educating (elderly) patients about life after retirement	-0.32	Taking patients from stations to stations in a hospital	-0.05
Leading group art sessions	-0.54	Educating patients about how to manage their surroundings	-0.38	Family counseling	-0.27
Family counseling	-0.56	Educating patients about self-care providing	-0.39	Individual counseling	-0.29
Designing jobs for the elderly	-0.56	Educating patients about (assistive) technology devices	-0.41	Designing jobs for the elderly	-0.35
Individual counseling	-0.59	Health education	-0.56	Managing an advance care planning meeting	-0.52
Managing an advance care planning meeting	-0.60	Educating patients about law	-0.56	Preparing medical equipment	-0.73

Note. CD = configuration distances.

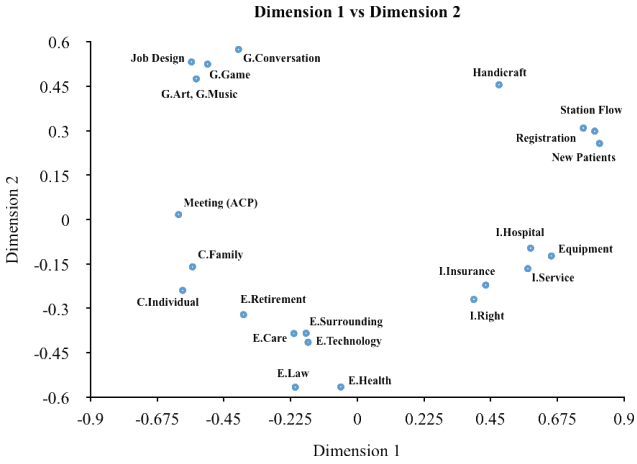
settings (e.g., facilitating new patients and guiding elderly patients) on the top. Activities not pertinent to facilitating patients to proceed along several steps in a hospital were placed on the bottom. The second dimension distinguished between leading group activities (such as group conversation and group game) and giving lectures to groups of people (such as giving information about health issues and providing knowledge on various topics). The third dimension that emerged was not fully clear. At the one end of the continuum, there was a group of activities such as conducting advanced care planning (ACP) meetings and counseling (except preparing medical equipment) that may require volunteers to communicate with patients in a thoughtful and caring manner. Hence, we tentatively named the three dimensions as *hospital-related*, *lecturing versus group leading*, and *empathic communication*, respectively. Note that the first and third dimensions were unipolar while the second dimension was bipolar.

Illustratively, each activity was located somewhere on a dimension continuum. For example, volunteers who are suitable for the group music activity may not need to have much familiarity with the locations and procedures of various medical sections as well as much empathy (i.e., low on the hospital-related dimension and the empathic communication dimension) but may need to be skilled in leading group activities (i.e., high on the group leading dimension). We also plotted each activity on a two-by-two dimensional space (Figure 1). On the top panel (1st-by-2nd dimensions), the activities were clearly arranged into four quadrants, where the activities in the first quadrant (top-right) included facilitating (older) patients on various tasks in a hospital. Those in the second quadrant (bottom-right) included providing information related to medical procedures and patients' rights as well as simplifying it to patients. Those in the third quadrant (bottom-left) included a mix between providing information related to patients' health and welfare and helping patients and their families in emotion-laden tasks. Finally, those in the fourth quadrant (top-left) included leading group activities. However, when examining the middle (1st-by-3rd dimensions) and bottom (2nd-by-3rd dimensions) panels, the activity groupings were less clear. Specifically, in the middle panel, the preparing medical equipment activity was only located in the second quadrant whereas, on the bottom panel, the activities in the lower part of the graph were sparse and scattering. Despite such findings, we nevertheless decided to retain the third dimension as it may convey the participants' impression that some activities might demand volunteers to be capable of dealing with emotional concerns.

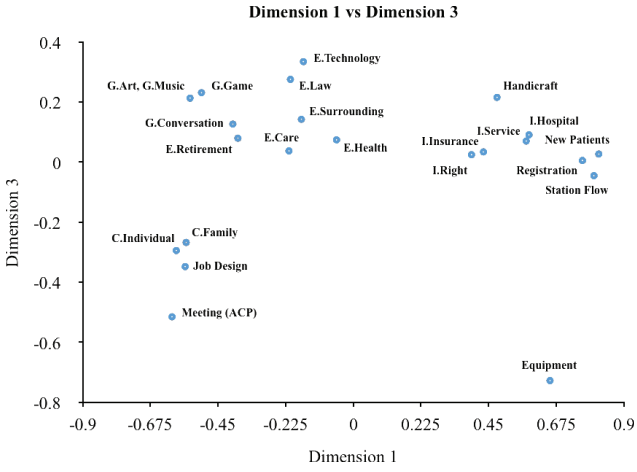
As a final note, the *smacof* package offers an indicator (stress-per-point contribution; Mair et al., 2015) to indicate how much each object (i.e., activity) has contributed to the lack of fit. Not surprisingly, the preparing medical equipment activity contributed the largest proportion (11.2%) of the misfit, signifying the participants' ambiguity as to on what dimension they should base this activity. Hence, we decided to ignore this activity when interpreting the third dimension (*empathic communica-*

Figure 1. Volunteer Activities on a Two-by-two Dimensional Space

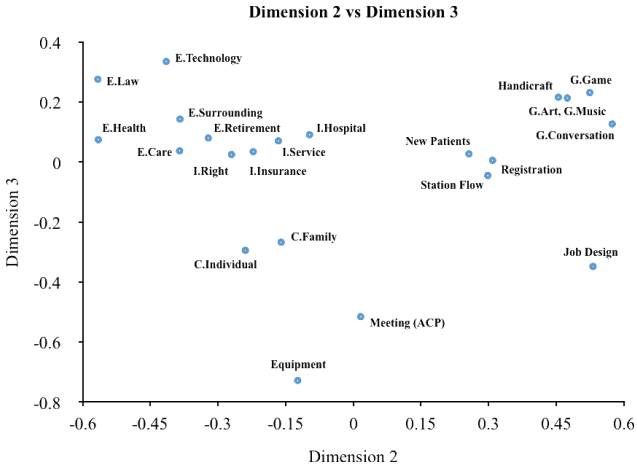
(a) Top: the hospital-related dimension (x-axis) x the lecturing and group leading dimension (y-axis)



(b) Middle: the hospital-related dimension (x-axis) x the empathic concern dimension (y-axis)



(c) Bottom: the lecturing and group leading dimension (x-axis) x the empathic concern dimension (y-axis)



tion). Nevertheless, we re-analyzed 22 activities (excluding preparing medical equipment) and still found three dimensions with the same meanings as found in the analysis with all activities (details not shown).

DISCUSSION

For exploring an initial structure of job tasks, where some tasks are hypothetical or going to be added in the future, a multidimensional scaling technique seemed to be suitable because this technique requires only a minimum input from the stakeholders while providing an opportunity to merge future tasks with current ones (for a good introductory source of multidimensional scaling, see Jaworska & Chupetlovska-Anastasova, 2009). This is different from a traditional job analysis where incumbents' critical experiences and judgments are sorely needed. The current treatment of rating the dissimilarity between objects (i.e., an adapted version of the hierarchical sorting tasks; Rao & Katz, 1971) also saved participants' time and energy while collecting data. In the current study, this technique meaningfully extracted three dimensions underlying the structure of 23 volunteer activities in a hospital setting. Medical personnel and veteran volunteers discerned each activity on (i) how much it required familiarity with hospital settings and procedures in order to facilitate patients (especially the elderly) to proceed from one point to another, (ii) the difference between the activities in which volunteers serve as an instructor conveying information or knowledge about certain topics and the activities in which volunteers serve as group leaders promoting interaction among group members, and (iii) how much volunteers need to deal with emotion-laden issues from patients and their family members.

These three dimensions (hospital-related, group leading, and empathic communication) well reflect the current practices in some government and municipal hospitals. Patients are often required to visit several checkpoints (e.g., from registration to receiving treatment and medicine). These checkpoints may be different from place to place and volunteers need to be familiar with the setting and procedure in order to guide patients effectively. Therefore, the hospital-related dimension would suffice for practical purposes.

Moreover, lecturing (or giving a talk) and leading group meetings are two main activities (among others) found in the healthcare team members' report in managing hypertension (Gomes, Caetano, & Santos, 2014). Although these types of activities are not located at the two extremes in the same continuum (Gomes et al., 2014), we postulate that individuals may perceive these activities as opposite in the hospital-based volunteering settings.

Additionally, a survey by Charles, Ahnfeldt-Mollerup, Søndergaard, and Kristensen (2018) found that general practitioners reported levels of empathy comparable to primary care doctors and higher than other specialists (which were hypothesized to be thing-oriented rather than human-oriented). Due to the differences between medical specialists and other types of medical practitioners, we extrapolated from this explanation to hospital-related volunteer activities in that some activities may require a great deal of empathic communication while the others may not require as much.

Although these three dimensions may not be comprehensive or detailed to cover all critical aspects of volunteer activities, this multidimensional scaling technique provided efficient and useful results for further planning. According to the characteristics of the three dimensions described above, we may be able to pinpoint some personal characteristics and experiences for volunteers in order to excel in each activity. For example, helping the elderly proceed through several steps in a hospital may require a volunteer characterized by a high level of service orientation (e.g., Carraher, Parnell, Carraher, Carraher, & Sullivan, 2006; McBride, Mendoza, & Carraher, 1997) and self-control (e.g., Gholamzadeh, Sharif, & Rad, 2011; Tangney, Baumeister, & Boone, 2004). For the second dimension, volunteers who convey information and knowledge may need a set of characteristics (e.g., those that may encourage life-long learning; Jirgensons, 2015) which are different from those needed by volunteers who lead group exercises (e.g., creativity; Zimmermann, Dupree, & Hodges, 2014). For the third dimension, it appears that some activities, such as counseling and conducting ACP meetings, require volunteers who possess certain abilities and traits such as interpersonal communication skills, empathy, and open-mindedness (Gladstein, 1977). As a consequence, this initial structure of the activities can be used to develop, theoretically and empirically, a blueprint of personal characteristics and experiences that would be advantageous to working on designated activities.

One interesting finding was that according to the stress-per-point contribution, the activity of helping medical staff prepare medical equipment and devices seemed to be a bit distinct from the rest. Participants may consider this activity to be unique and not connected with other activities, at least under the dimensions extracted. Hence, from a practical standpoint, we put the preparing medical equipment activity as a stand-alone unit, possibly requiring a different set of personal characteristics and experiences from the rest (e.g., no need for volunteers who are high in empathy or caregiving traits).

With decent psychological measures, this activity structure (and psychological attributes each activity requires) may enable us to design a computerized, adaptive system for volunteer screening and placement (Barney & Fisher, 2016). Initially, a person who wishes to participate in volunteer activities may register using an online system and respond to some demographic items and psychological measures assessing relevant personal characteristics. Given that one can assess volunteer performance (perhaps from various sources such as supervisors, patients, and self-ratings), the computerized system could provide a feedback loop to update and refine a proper set of personal characteristics and/or psychological measures for further use. With a surge of statistical learning methodology in the realm of psychological assessment

(Chapman, Weiss, & Duberstein, 2016), it is interesting to investigate whether a construct-based approach or an item-based approach can be a better, more cost-effective, choice in predicting volunteer outcomes. This finding can guide the management of volunteer activities in hospital settings. Particularly, the volunteer activity selection can be done based on the person-job fit, which may lead to better outcomes for volunteers/employees (Boon, Hartog, Boselie, & Paauwe, 2011). Volunteers, who will be recruited based on a person-job fit approach, may be more satisfied with volunteering work, which may lead to better job performance. The re-design of a volunteering process based on the person-job fit approach will be more likely to increase work effectiveness among volunteers and medical staff as well as to improve patients' positive experience of a hospital visit.

Some limitations and consequent suggestions for future research are worth noting. First, due to the method of producing the dissimilarity scores for a large group of objects, different participants may have used different criteria in generating their ratings. For example, while some participants judged the most dissimilar activities by a score of nine, others may have given a score for the most dissimilar activities to be a seven or eight. As the aim of this study was to get a rough picture of the dimensions underlying the volunteer activities (not an accurate estimate of the configuration distances), this limitation does not pose a serious threat to the findings' validity.

Second, the proposed three dimensions (hospital--related, group leading, and empathic communication) should be viewed as a preliminary result due to the small sample size. Nonetheless, the number of 30 participants in this study appears to be adequate for metric recovery in nonmetric multidimensional scaling (Rodgers, 1991) and was not uncommon in the literature (Bimler & Kirkland, 2007; McConnell & Marton, 2013).

Third, some participants might not fully understand the nature of volunteer activities in the hospital. This situation could affect individuals' ability to evaluate the degree of similarity between the various volunteer activities. Prior to the data collection, a brief information of 23 volunteer activities was presented. Only a few participants asked further questions about these activities, which were answered by the workshop instructor. During the judging task, our research assistants were available to answer further questions. We did not observe any signs of confusion nor further questions asked by the participants.

Fourth, the participants of this study comprised of medical doctors, nurses, and veteran volunteers who may have different perspectives on the nature of volunteer activities. Due to a limited access to specific occupational records of the participants, we could not analyze each subgroup separately. Further, future studies could extend our quantitative findings through the qualitative approach (e.g., focus group or text analysis) so that one may gain more insight into the underlying processes of dimension extraction. The computing and visualizing tools such as MAXQDA or text analysis software would be very helpful in this endeavor. Ultimately, a multidimensional scaling technique, with a proper method of scoring dissimilarity between objects, seems to be a good starting point for examining the structure of volunteer activities and its underlying dimensions, especially when some activities are not readily accessible (e.g., will be active in the future).

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