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Exploring impacts of project leaders' written expressions in virtual and fluid projects: The role of personality and emotion

Research-in-progress

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ABSTRACT

This paper aims to tackle challenges of managing projects in highly virtual and fluid contexts, characterized by features such as diversity, dispersion, digital dependence, unstable membership, and dynamic coordination and configuration. We investigate project leaders' personalities and emotions implied in written expressions, and their impacts on collaboration outcomes. IBM Watson Personality Insights and Tone Analyzer were adopted to assess the leader's personality and emotion. A computation model to classify collaboration patterns into taskwork-related and teamwork-related communication is under development. We report preliminary findings based on 417 weekly meetings between October 2018 and February 2020 in 8 open-source software teams around WordPress. The research results have the potential to inform researchers and practitioners about what personality profiles and emotions should be considered to foster collaboration in virtual and fluid projects. It is possible to extend the *traits* perspective in leadership for project management in the VF context.

Keywords

Project leader, emotion, personality traits, open-source software teams, machine learning methods

INTRODUCTION

Virtual project teams allow organizations to tap into global talent, achieve sustainability goals, and save travel-related time and costs. They are also inevitable when the workplace is disrupted due to terror attacks, natural disasters, or pandemics. Despite continuous evolution of industry practices and research, both practitioners and researchers find it challenging to manage virtual projects. Virtualness, which is characterized by some combination of geographical distances, dynamic team configurations, time zones, and media richness (Hacker et al., 2019), decreases trust and shared understanding, and heightens relational conflict and counterproductive behaviors (Alsharo et al., 2017). More recently, increasing fluidity exacerbates problems (Chiu et al., 2017), where project leaders need to manage unstable team membership (Mortensen & Haas, 2018), and dynamic team structure (e.g., roles/responsibilities) and interaction patterns (Summers et al., 2012). When virtualness and fluidity intertwine, project leaders and members do not have time to familiarize with each other, thereby preventing effective taskwork

and relationship building (Huckman & Staats, 2013). To ensure success in a project characterized by virtualness and fluidity (hereafter VF projects), project leaders must proactively glue members, including conflict management, motivation and confidence building, and affect management (Malhotra et al., 2007).

Among various project management competencies (Alvarenga et al., 2019; Napier et al., 2009), emotional competencies are crucial for team processes and project success in information systems projects (Müller & Turner, 2007). According to the *traits* perspective in leadership (Gehring, 2007; Müller & Turner, 2010), project members perceive leader's emotions and personalities, which in turn affect their cognitive processes, creativity, motivation, task performance, and wellbeing (Aronson et al., 2008; Brotheridge & Lee, 2008). The relationships between the project leader's personality, emotion, and project outcomes have been established (Aronson et al., 2008; Hu & Judge, 2017). However, in VF projects, project leaders must overcome a few obstacles to exert their influences. First, they need to sense emotion swiftly and accurately based on limited interaction opportunities with unfamiliar team members. Second, they need to be adaptive for evolving emotional and contextual needs. Third, reliance on text as a primary means to communicate task and social information undermine leaders' sensing and adaptation capabilities. Project leaders should know the implications of written expressions used in their communication.

This research aims to support project leaders in VF projects by investigating the role of project leaders' personalities and emotions implied in written expressions. Based on research that personal traits, such as personality, are malleable (Dweck, 2008; Roberts et al., 2017) and emotion can be regulated (Edelman & van Knippenberg, 2017), we explore the relationship between the personality and emotion of leaders implied by written expressions, and subsequent collaboration using machine learning techniques. We are analyzing 417 weekly meetings between October 2018 and February 2020 in 8 open-source software (OSS) teams around the OSS project – WordPress. These teams are highly virtual, purely relying on textual communications using Slack, and highly fluid where team members can come and go frequently and have fluid roles and responsibilities. In contrast to conventional methods using interviews and questionnaires to assess the personality and emotion of individuals, advance in machine learning and psycholinguistics offers an opportunity to understand psychological processes based on text features (Yarkoni 2010). We adopt IBM Watson Personality Insights and Tone Analyzer to assess leaders' personality traits and emotions. We are developing a computation model using machine learning to automatically code collaboration patterns into taskwork-related and teamwork-related communication (Marks et al. 2001).

This study sets out to extend theory and practice in several important ways. First, the research results have the potential to inform researchers and practitioners about what personality profiles and emotions should be considered to foster collaboration in VF projects. It is possible to shed new lights on leadership in the VF context. Second, due to constraints including limited availability of data, resources, and time, most research focusing on personality, emotion, and collaboration has been cross-sectional as opposed to longitudinal. Drawing on automated personality and emotion detection mechanisms, we will reveal if, and to what extent, project leaders adapt their personality trait and regulate their emotions over time. Third, an automated mechanism that mimics manual coding is proposed to track collaboration patterns. As a result, longitudinal research has become far more achievable. The proposed automated mechanisms have the potential to serve as a project management tool for project leaders to assess their written expressions and teams proactively.

CONCEPTUAL BACKGROUND

Influences of the Leader's Personality and Emotion

The Big Five personality framework is well established to understand leaders' personalities. A meta-analysis by Judge et al. (2002) on personality and leadership emergence/effectiveness found that emotional stability, extraversion, openness and conscientiousness explained the effectiveness/emergence of a leader. In the project setting, project leaders who are conscientious help project teams to persist in their effort to achieve project goals, as well as supporting team members (Moore & Vucetic, 2014; Müller & Turner, 2010; Thal Jr & Bedingfield, 2010). Extravert project leaders express positive emotions and are optimistic about project future, thereby lifting project team morale and spirits (Bono & Judge, 2004). Project leaders who have high emotional stability and are less neurotic are more likely to support their project members (Müller & Turner, 2010). Considering the fit between the nature of projects and personality traits of project leaders, in new product development projects, which are characterized by its uncertain requirements and scope, project leaders who are open to experience (i.e., those who are creative and curious about opportunities) have been of particular value as they are willing to embrace uncertainty and experiment with novel ideas (Aronson et al., 2006). There are mixed outcomes for conscientiousness ranging

from insignificant (Aronson et al., 2008) to significant (Aronson et al., 2008) impacts on team processes and project success. On the one hand, conscientiousness indicates leaders' organization and hard work in the pursuit of challenging goals in a highly uncertain environment. On the other hand, project members may not appreciate project leaders' persistence if they do not agree with the project direction. Although extraversion and emotional stability can help project members withstand stress in highly uncertain contexts, previous research found they mainly contribute to projects with low uncertainty (Aronson et al., 2006). It is important to acknowledge the significance of a leader's personality traits which ultimately influence the achievement of team processes and project outcomes. Nonetheless, the role of personality traits on team processes in VF projects remains unclear and warrants further investigation.

Leadership theories, including the *traits* perspective, encompass emotions, either explicitly or implicitly, as an important component of an effective leader. In a team setting, emotions deliver rich manifestations which impact team commitment and ultimately the performance. Hence, from a leader's perspective, not only is there a need to self-regulate one's own emotions but also manage the emotion contagion effect within a team (Riggio & Reichard, 2008). Factoring the emotions of a leader alongside the *traits* view can prove helpful in developing a holistic understanding of leader-member exchange. A recent body of literature is emerging on how leaders' emotions impact various team processes. Koning and Van Kleef (2015) found that a leader's emotion of anger negatively impacts the organizational citizenship behaviors of team members. Nylund and Raelin (2015) put forth that knowledge transfer from leaders can be anchored in emotions. They found that this emotional knowledge transfer is linked to negative reactions from the follower. The above discussion indicates the interplay of emotions and (task/social) team processes in shaping goal attainment.

Perceptions of the Leader's Personality and Emotion and Communication Patterns

People use all the available cues, such as communication (de Vries et al., 2013) and nonverbal cues (Gilbert & Krull, 1988), to understand others' emotions and personalities. In pure-text communications, project members use written expressions in determining which personalities and emotions are conveyed (Hickman et al., 2019). Such use of natural language has been empirically tested against broad ranges of personality data, establishing a correlation with other methods of personality measurement including self-report, acquaintance report, and behavior (Fast & Funder, 2008). It is suggested that languages associated with leaders' personalities and emotions impacts team members' interpretation of a message and accordingly collaboration behaviors (de Vries et al., 2010).

Among various elements of virtual collaboration (Lindberg et al., 2016), we study communication patterns in team processes as they are proximal to leaders' written expressions. We contend that communication patterns capture team members' responses to leaders' personalities and emotions. Collaboration-related communication can be generally categorized into taskwork-related and teamwork-related (Marks et al., 2001). Taskwork involves the completion of tasks, whereas teamwork is concerned about the social aspect of team functioning. Taskwork-related communication can be further differentiated into content communication, which addresses issues related to tasks, tools, and systems, and process communication, which covers how to work together to accomplish tasks (Straus, 1999). Teamwork-related communication is non-task related, such as interpersonal conversations and off-topic communication. We postulate that leaders' expressed emotions and personalities in text influences communication patterns of teams. For instance, when team members feel a sense of openness and warmth in team communication, they are more likely to share their ideas (Wang, 2015). Positive emotions by project leaders can also encourage innovative ideas (Amabile et al., 2005). Extrovert project leaders prefer to elaborate task information and engage in process communication (Bradley & Hebert, 1997).

Personality Detection and Natural Language

In measuring personality, analysis of natural language has been used pervasively throughout personality psychology (e.g., Majumder et al., 2017). This largely because of the scalability that comes with only needing natural language in the form of text compared to surveys or interviews which require the more extensive and active collection of data. This analysis of personality from natural text relies upon the 'Lexical hypothesis' which assumes that important expressions of personality eventually become part of language and that more significant expressions of personality tend to be encoded in single words (Saucier & Goldberg, 1996).

Automated analysis of text based on this principle has become particularly popular given the quantity of text freely available on social media (e.g., Pratama & Sarno, 2015) and the scalability of such measurement. This personality measurement mechanism has seen continued and pervasive use, recently being used to identify the impact of

personality on successful online learning (Abe, 2020) and to identify the impact of CEO personality on company strategic change (Harrison et al., 2019).

To provide the best insight into the personalities of the leaders, this research uses the Big Five type indicator. This personality model was selected for several reasons. Firstly, the Big Five type indicator presents high validity in the form of test-retest reliability, behavioral predictive power, & construct validity (e.g., Phipps et al., 2015). Secondly, due to its pervasive use within the field of personality psychology, the amount of resources associated with the Big Five are significantly higher than alternatives. Among the Big Five personality measurement tools, the IBM Watson Personality Insights tool has proved to be valid. IBM's in-house testing of the tool produced an average Mean Absolute Error of 0.12 and Average Correlation of 0.31 in English (IBM Cloud, 2020) making it comparable to state-of-the-art text-mining approaches (Hickman et al., 2019).

Emotion Detection and Natural Language

Emotion categorization, like personality measurement, aims to measure the emotional expression of humans in a range of media. Where the field of personality psychology has had well-established personality models with somewhat clear pros and cons between them, the field of emotion classification has significantly fewer well-established models with a less established understanding of the pros and cons of specific models (de Raad et al., 2014). Additionally, where personality psychology has, for the most part, focused on the lexical hypothesis (de Raad et al., 2014), emotion classification models are produced from a range of different areas (Tracy & Randles, 2011). Such differences in origin produce distinct differences in the evaluation of what the most 'basic' emotions are. It is difficult to definitively ascertain the most accurate model given the unclear pros and cons of each distinct model. However, a 2016 survey of 248 scientists identified as studying emotion produced this list as the top five most "agreed upon" empirically established emotions: Anger (91%), Fear (90%), Disgust (86%), Sadness (80%), and Happiness (76%) (Ekman, 2016).

The IBM Watson Tone Analyzer is one of IBM Watson's many Artificial Intelligence text analysis tools. It utilizes an ensemble of lower-level models into a high-level model which incorporates features such as n-grams, punctuation, emoticons, curse words, greetings, and sentiment polarity. The datasets on which it was trained includes ISEAR and SEMEVAL. The emotions produced a map to four of the top five most agreed emotion categories (Ekman, 2016). The IBM Tone Analyzer tool has seen extensive use in emotion classification academia, having been used to detect emotion in a range of context (Al Marouf et al., 2019). On top of emotions, the IBM Tone Analyzer also detects three 'Tones': 'Analytical', 'Confident', and 'Tentative'. These are not the focus of this research and thus we will be looking at only the Emotions produced, rather than the tone.

While leaders' personalities and emotions are of fundamental importance to team members and team processes, as shown in the above review, how they operate in the highly VF context needs to be explored. Advances in natural languages offer opportunities to detect emotions and personalities implied by written expressions of leaders. This paper leverages modern technologies to study an emerging phenomenon that is currently under-researched. We adopt machine learning techniques to assess leaders' implied emotions and personalities and how they influence team communication outcomes in VF projects. The findings will further our understanding of project leaders' personalities and emotions and how they should be managed. The following sections discuss the investigation procedures, preliminary outcomes, and potential implications.

RESEARCH METHOD

In this research-in-progress project, we empirically explore the personality and emotion of leaders based on their written expressions and test their impacts on collaboration processes. We chose to study the WordPress open-source community. WordPress is the most popular open-source content management system, which has been used by 35.9% of the websites (W3Techs, 2020). A group of volunteers, forming 18 teams with different responsibilities (e.g., design, programming, testing, training), contribute to the development of WordPress. Slack, a business communication platform, is the channel for real-time communication. The Core Team, working on coding WordPress, is the largest team. More than 30,000 team members are on their Slack channel. Our focus is on teams' regular meetings within the WordPress Slack. While there is a variety of meeting norms between teams, most included weekly hour-long meetings discussing topics such as upcoming events, plans, and team organization. We select eight teams for analysis based on the following criteria. The first is stable leadership to properly assess the impacts of leaders and ensure enough text to be analyzed. In OSS, project leaderships are emergent and can be

shared by more than one person. We include leaders that have had considerable representation in the last two years. We selected 15 leaders from 8 teams. All of them led more than ten meetings in their team. The second criterion is that of the presence of documented agendas and/or summaries. This can be used to understand the significance of discussion topics. Based on these criteria, we collected meetings between October 2018 and February 2020. Table 1 summarizes the nature of the team and the number of available meetings for each team.

Team	Description	Available meetings
Accessibility	The accessibility group provides accessibility expertise across the project, making sure that WordPress core and all of WordPress' resources are accessible.	169
Documentation	The docs team is responsible for creating documentation.	143
Community	The community team organizes support events, outreach, training programs and other community engagement.	33
Polyglots	The polyglots team manages the translation of WordPress and maintenance of localized pages.	273
Training	The training team creates downloadable lesson plans and related materials for instructors to use in a live workshop environment.	203
Support (Forums)	The support team manages user support and helps resolve problems related to the use of WordPress.	194
Core	The core team makes WordPress. This involves writing code, fixing bugs, debating decisions, and helping with development.	141
Design	The design team is focused on designing and developing the user interface.	133

Table 1. Description of the Selected Teams

Data Analysis

Assessment of Leader Personality and Emotion

Leader personality was assessed by accruing their messages from all meetings that project leaders led. Aggregated messages from each project leader were then sent to the IBM Watson Personality Insights via IBM Cloud API. Personality Insights service returned the percentile. For example, Leader 1 of the Accessibility team receives a 98% on Openness to Experience and means that she is more open than 98% of the people in the population.

To assess leader emotions, we adopt the IBM Watson tone analyzer because of the breadth of models incorporated in the tool, the number of datasets used in training, the extensive precedent within the literature, and the inclusion of four of the five most agreed upon emotions (Ekman, 2016). Unlike the leader's personality, emotions were analyzed at the level of individual comments. After receiving the likelihood of the emotion for each sentence from Tone Analyzer services, we calculated the proportion of sentences that exceed 0.75 of a probability score for different emotions: Anger, Fear, Joy, Sadness.

Coding Communication Patterns in Teams and Machine Learning

To understand how project leaders' personalities and emotions influence team processes, we are analyzing communication patterns in meetings. We plan to adopt a supervised machine learning model, where human experts first label data set as the "ground truth" of the training dataset for supervised machine learning model. The defined "ground truth" is then used to evaluate the accuracy of the computed model via a comparison between correctly and incorrectly classified data. We have developed a coding scheme for team processes. Given a limited understanding of communication patterns in the OSS context, a mixed approach has been used, incorporating a hybrid of inductive and deductive coding (Fereday & Muir-Cochrane, 2006). It started with a coder immersing in the data and developing initial codes. Then the research team discussed and interpreted meanings of initial codes. Through several iterations of coding and reflections, a modified set of codes was produced, incorporating some structural elements from McGrath (1984). The categories produced were as follows: Process Communication, Planning, Creativity, Decision-making, and Social. The exact definitions of these were modified to fit with the virtual meetings, as outlined in Table 2. We plan to code 10,500 dialogue sentences with these labels use the fine-tuned pre-training embedded model (Google, 2020) to predict communication patterns in each meeting.

Category	Description	Typical Example
Process Communication	Communication about elaboration on task information and how to go	"What are actionable steps that we would like to take on this?... Investigate the potential of creating the new role

	about accomplishing the task.	and then creating that role then testing carefully and assigning the people”
Planning	Generating new plans, especially goals/strategy/timelines.	“One thing I'd like to have as a goal is more aggressive work during alpha, so that we can dedicate more attention to the final product during beta & RC.”
Creativity	Generating new ideas.	“This one [requirement ticket] really needs more feedback. Does anyone have any thoughts around this? It's suggesting adding a new widget. On the one hand, I feel these notices don't really stand out as much as they should when they're in the 'At a Glance' widget. On the other, I don't think adding another widget is a good approach.”
Decision-making	Tasks require reaching consensus on a preferred answer.	“I believe the new space is good, but it will be better if we have a channel here, don't you think?”
Social	Social interactions, jokes, etc. between members.	“Ok everyone, let's start gathering around the fire...”
Administration	Structural organization of meetings, announcements, & delegation.	“first item on the agenda is Update on 5.4 trac tickets”

Table 2. Coding categories for team processes

PRELIMINARY RESULTS

Leader's emotional characteristics and personality traits

Table 3 summarizes personality traits of 15 project leaders. Each leader communicates more than 3,000 words, sufficient to generate strong analysis (IBM Cloud, 2020). These leaders scored high in Conscientiousness (Average percentile rank is 80%) and Openness to Experience (Average percentile rank is 94%). Openness to Experience appears to match their responsibility to invite participants to express their ideas and share information. Conscientiousness, on the other hand, appears to match the responsibility of keeping the meeting organized and on-track and achieving project goals. If this were so, it would support the notion of the 'situated personality' where individuals adjust the expression of their personality based on the context.

Team - Leader	Personality Trait					Word Count	# of meetings
	A	C	E	N	O		
Accessibility - Leader 1	2%	60%	7%	57%	98%	28526	34
Accessibility - Leader 2	5%	52%	11%	42%	98%	25710	24
Accessibility - Leader 3	37%	97%	25%	61%	94%	5838	10
Community - Leader 1	39%	93%	58%	34%	93%	4816	13
Community - Leader 2	57%	88%	72%	21%	97%	7314	11
Core - Leader 1	40%	82%	31%	73%	95%	20455	27
Core - Leader 2	19%	90%	20%	64%	96%	17447	23
Core - Leader 3	6%	81%	13%	76%	95%	9835	22
Design - Leader 1	58%	87%	41%	63%	93%	36283	60
Documentation - Leader 1	12%	56%	21%	40%	94%	24313	38
Forum - Leader 1	17%	64%	20%	57%	97%	37478	52
Polyglots - Leader 1	7%	74%	15%	69%	95%	26477	41
Polyglots - Leader 2	39%	84%	26%	68%	90%	6617	11
Training -Leader 1	13%	95%	11%	18%	94%	33114	39
Training -Leader 2	16%	91%	27%	56%	77%	4816	13
Average percentile rank	25%	80%	27%	53%	94%		
Standard deviation	19%	15%	18%	18%	5%		

Note. (1) A: Agreeableness, C: Conscientiousness, E: Extraversion, N: Neuroticism, O: Openness

Table 3. Project Leaders' Personality Traits

Table 4 summarizes the proportion of the messages that convey anger, fear, joy, and sadness by each leader. As all meetings are text-oriented, emotions may not be explicitly expressed. The meeting context with high virtualness and fluidity is also not conducive for displaying emotion. Still, some project leaders expressed more positive emotion than others (Max: 16.2% and Min: 4%). As OSS projects are not bounded to time and resource constraints, project leaders seem to display fewer negative emotions, such as anger, fear, and sadness.

Team - Leader	Emotion				Message count	# of meetings
	Anger	Fear	Joy	Sadness		
Accessibility - Leader 1	<0.1%	<0.1%	4%	0.7%	4056	34
Accessibility - Leader 2	0.3%	5.1%	5.7%	0.8%	3276	24
Accessibility - Leader 3	<0.1%	0%	7.4%	0.6%	1035	10
Community - Leader 1	<0.1%	0%	9.2%	0%	509	13
Community - Leader 2	0%	0%	12%	0.2%	757	11
Core - Leader 1	<0.1%	0.1%	7.9%	0.6%	3872	27
Core - Leader 2	0.1%	0.1%	7%	0.5%	2893	23
Core - Leader 3	0.1%	0.2%	5.9%	0.9%	2452	22
Design - Leader 1	0.1%	0.2%	10.3%	0.7%	7289	60
Documentation - Leader 1	0.3%	0.2%	6.8%	0.8%	4160	38
Forum - Leader 1	0.3%	0.5%	6.5%	1.2%	4709	52
Polyglots - Leader 1	<0.1%	0.2%	9.5%	0.7%	2403	41
Polyglots - Leader 2	0%	0%	16.2%	0.3%	617	11
Training -Leader 1	0.1%	0.3%	7.8%	0.4%	3881	39
Training -Leader 2	0%	0%	9.9%	0.4%	507	13

Table 4. Project Leaders' Emotions

FUTURE STEPS, EXPECTED OUTCOMES, AND POTENTIAL IMPLICATIONS

This research-in-progress paper presents our preliminary analysis of leaders' personalities and emotions situated in project communications, showing variations of leaders' written expressions across teams. For the next step, we will complete coding collaboration patterns and train our classification model. We will conduct statistical comparisons between the model's predictions and actual data. We also plan to conduct interviews with OSS project leaders and team members to ascertain if they agree with the model's predictions. Once we confirm the validity of the classification model, we will examine the relationship between the leader's emotion and personality and communication patterns. We expect to discover different personalities and emotions expressed by leaders result in different communication patterns. Given the nature of the data and the constraints of machine learning techniques, this study has certain limitations, which shows potential future research opportunities. First, the data is limited to an open-source software project – WordPress and the results should be generalized with caution. For instance, team size and cultural differences can moderate the relationship between leaders' behaviors and team outcomes (Pratoom, 2018). Future research can explore teams with various cultures and team size in other open-source projects or sectors. Second, our analysis mainly focuses on text and remove emojis and emoticons as they are not standardized and add noises. However, emojis and emoticons can be used in sentiment analysis (Peacock & Khan, 2019). Future research can further investigate the effect of emojis and emoticons.

The outcomes of this project have the potential to inform the management of VF projects. Project managers can gain a better understanding of written communications in project teams characterized by features such as diversity, dispersion, digital dependence, unstable membership, and dynamic coordination and configuration. The development of automated detection mechanism can provide immediate feedback to project managers. Besides practical implications, the research also has the potential to contribute to theory elaboration (Fisher & Aguinis, 2017). The findings will extend the *traits* perspective in leadership and emotion regulations to the new context, which can inform new leadership behaviors in the high VF context. Furthermore, to our knowledge, automatically code communication patterns of software-related tasks is novel and can be useful for research in team coordination and collaboration. Our research will pave the way for future research in project management that leverages machine learning techniques.

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