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FROM OBSTACLES TO OPPORTUNITIES: HOW PERCEPTIONS OF PSYCHOLOGICAL SAFETY AFFECT FOUNDERS' ABILITIES TO IDENTIFY RESOURCES

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ABSTRACT

Resources are a dynamic aspect of team problem solving and the ability to properly manage them is a critical factor for success. Engineering design teams often face challenging resource deficits, and effective resource management is paramount in resource constrained environments. While prior work has linked effective resource management at the firm level with the climate of the firm, little work has explored these linkages at the team level. Here, we study the interactions between team climate and the ability to identify meaningful resources that mitigate current obstacles. We quantify team climate as individual perceptions of psychological safety, or one's perception of the team's willingness to engage in interpersonal risk taking. In this work, we leveraged data from thirty-two startup company founders, a population of authentic problem solvers that often operate in resource constrained environments, to study this relationship. The results from our mixed-methods study indicate that individual perceptions of psychological safety predict founders' ability to identify meaningful resources to mitigate obstacles they are currently facing. Thus, problem solvers that perceive their team climate to be more positive, or more psychologically safe, exhibit a greater ability to identify meaningful resources.

Keywords: Team Problem Solving, Psychological Safety, Resource Identification

1. INTRODUCTION

Engineering design is a complex form of problem solving [1, 2] in which *the principal role of a designer is to make decisions* [3]. Marston et al. [4] have identified such design decisions as an *irrevocable allocation of resources* [5]. The engineering design process is inherently ambiguous, and key facets of the process, such as the project scope [6], are often unclear. Designers and design teams often experience sudden changes in problem constraints [7, 8] or shifts in project requirements [9] and are commonly tasked with generating well-defined solutions to ill-defined problems [10]. A significant body of work within engineering design has investigated uncertainty, specifically during requirement specification [11], identifying several methods to overcome this uncertainty. Part of this uncertainty stems from a gap between customers' expectations and the resources available to designers to meet these expectations. However, the availability of resources, such as time, money, or materials, can change throughout the design process, and can affect a design team's problem-solving efficiency [12]. Designers must remain flexible and agile to adapt decisions based on changes in resource availability; this skill is particularly crucial in resource constrained environments because the ability to identify and allocate resources can decrease project duration [13] and is a critical factor for success [14].

While we are all familiar with the phrase "necessity is the mother of invention", the literature remains split on the effects of resource scarcity on invention and innovation. For example, [15] found that a scarcity of resources adversely affects the abilities of small- to medium-sized enterprises to develop and promote innovative ideas. Yet, Weiss et al. [16] found that a scarcity of financial resources actually contributed to the development of more creative and innovative ideas. Importantly, team climate, defined as a shared perception of the team, task, and environment that affects the willingness of members to take risks, collaborate, or exchange information [17], was found to positively moderate the relationship between financial resource scarcity and the team's innovative abilities.

Psychological safety [18], or a team's willingness to engage in interpersonal risk taking, has been identified as a consistent and generalizable measure of team climate [19], especially for complex tasks that are knowledge-intensive. For example, Cole et al. [20] found that positive communication predicted greater

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psychological safety and was an important factor of perceived success in engineering design teams. In terms of measurable team success, [21] found that psychological safety was a predictor of idea goodness, or the overall quality or effectiveness of an idea [22]. Psychological safety has also been found to affect team knowledge creation, where teams with greater levels of psychological safety engaged in more team learning behaviors and created more team knowledge [23]. While the effects of team psychological safety in engineering design have been explored in recent literature, its relationship with the ability to identify meaningful resources, a critical factor for success, has not yet been studied.

The aim of this paper is to investigate the effects of perceptions of psychological safety on perceptions of obstacles and resources in teams. The rest of this paper is outlined as follows. Presented in Section 2 are the theoretical underpinnings of which this work builds upon. Our methods are presented next in Section 3. Section 4 presents the results from this study, followed by the discussion in Section 5. Limitations of this work and areas of future work are presented in Section 6. Finally, Section 7 presents the conclusion.

2. BACKGROUND

The following subsections review relevant literature from resource and innovation management, engineering design, and entrepreneurship, as well as present research gaps that motivate our current work.

2.1 Resource Use in Teams

Resources are a dynamic aspect of engineering design [24] that exist in both surplus and scarcity [25] and are often subject to rapid change. Resource deficits occur when the amount of an available resource suddenly decreases, or its demand suddenly increases. In design, resource deficits that affect performance include time [26], money [27], human capital [28], and physical resources such as building materials or tooling capabilities [29]. Design teams work in environments with limited resources and often experience resource scarcity—or the inability to cope with resource deficits [30]—but the literature surrounding the effects of resource scarcity is divided. For example, [31] found that in small- and medium-sized enterprises, resource scarcity positively affects incremental innovation performance, but not radical innovation performance. This finding indicates that teams may be able to benefit from resource scarcity if they take incremental steps towards innovation. In contrast, recent work by Kusimo and Sheppard [32] studied product development teams and found that resource scarcity hinders team coordination and performance. Further, dealing with such resource scarcities can stymie cognitive control [33] and elicit discounting behavior [34], forgetfulness, and exaggerated risk averse behaviors [35].

When an individual operates in a resource scarce environment for an extended period of time, they could succumb to a "scarcity mindset"; Shah et al. [36] posit that *scarcity creates it's own mindset*, where individuals shift their focus where scarcity is most salient. Scarcity mindset is considered a deviation from rational decision making; it can directly hinder one's cognitive function and can deplete their cognitive resources such as attention and working memory [30]. Scarcity mindset can also cause individuals to struggle with planning, make trade-off-based decisions, and work reactively rather than proactively [37]. Decisions made while experiencing scarcity mindset are often not ideal because they can be based on a resource or problem fixation that may worsen the scarcity itself. Practically, this fixation causes individuals to neglect important tasks to accommodate urgent, but less important tasks. For example, when engineering students experience a time scarcity, they often neglect personal relationships as a trade-off for completing academic assignments [38]. They also tend to focus on short-term assignments and fail to proactively begin larger and more time-consuming assignments, which has been linked with a decrease in their work quality [39]. In design teams, this attentional shift also induces cognitive overload, which decreases their ability to effectively solve problems [36].

While resource scarcity may negatively affect problem-solving teams, Mishina et al. [40] found that in small- to medium-sized enterprises, resource slack, or resource abundance, does not always promote growth. Sok and O'Cass [41] also argue that the inherent value of resources is not automatically absorbed by teams. Rather, they argue that resources have potential value that is determined by a team's ability to properly manage them. To optimize this value, resource planning, allocation, and scheduling are critical for success, especially in competitive environments such as engineering design and entrepreneurship [42]. In fact, many researchers have developed methods for team resource management in hopes of improving project outcomes and success. For instance, Georgiopoulos et al. [43] developed a framework for analyzing resource allocation in firms to optimize their design decisions. Xin Chen et al. [42] developed a method of modeling different types of resources to explore various resource combinations in a design space, and Qiu et al. [44] employed a risk-based resource allocation methodology to be used in collaborative system design. While this prior work has identified and simulated the importance of team resource management for project success, it remains unclear what constructs affect the abilities of team members to correctly identify resources to overcome obstacles in practice.

2.2 Psychological Safety

Edmondson's [18] theory of psychological safety, or the shared belief that a team is safe for interpersonal risk taking, is a team-level construct that can be used to approximate team climate. Psychological safety is particularly critical for team performance in knowledge-intensive and complex tasks that require creativity and sense-making [45]. In fact, a team's level of psychological safety affects members' willingness to share knowledge and communicate openly [46]. When team members are willing to communicate openly without fear of failure, they contribute more efficiently to the team [19] and leverage the *wisdom of the collective* [47], where teams that successfully interact yield greater success. The effects of psychological safety on team performance have been consistent across fields including management, organizational behavior, and healthcare management [19]. Psychological safety has been shown to mediate the

relationship between inclusive leadership and innovative work behavior in management [48] and is positively related to innovation performance and innovation capabilities when studied as an organizational-level construct [49]. In healthcare, where team success and quality patient care are paramount, psychological safety predicted team involvement in learning and quality improvement across twenty-three intensive care units [50]. While psychological safety is a consistent and generalizable predictor of team performance across these fields, studying its effects on engineering design teams is more nascent. In addition, because design is a unique form of problem solving [51] and designers represent a unique population [52], these findings may not generalize with design.

In the context of engineering design, psychological safety has been identified as a dynamic and reliable measure of team climate over time, meaning that a team's psychological safety can be fostered and measured throughout the design process [20]. Cole et al. [21] found that teams with greater levels of psychological safety generated higher quality ideas than those with lower levels of psychological safety. Cauwelier et al. [23] studied French and American engineering teams and discovered that increased team psychological safety leads to increased learning and knowledge creation. These findings have motivated more recent work to focus on promoting greater team psychological safety in hopes of improving team performance. For instance, Scarpinella et al. [53] discovered that team psychological safety can be improved during the design process by providing an intervention that included an introductory video on psychological safety as well as a series of primer videos about fostering psychological safety throughout the design process.

While psychological safety is a team construct, prior work has studied the effects of individual perceptions of psychological safety. Individual perceptions of psychological safety are a single team member's own perceptions of the team's climate. Studying individual perceptions of psychological safety can provide insights on how members of the same team experience varying levels of psychological safety. For instance, [54] studied design teams and identified a discrepancy in perceptions of psychological safety between men and women. Women exhibited greater levels of perceived psychological safety when working with other women than when working with men. In contrast, men did not indicate any difference in perceived psychological safety with either gender. Startup teams, like design teams, operate in resource scarce environments working to solve complex problems. As such, team psychological safety has also been investigated in the field of entrepreneurship; it has been linked with greater levels of entrepreneurial bricolage [55, 56], or the ability to "create something from nothing" [57]. In preliminary work, the authors studied startup founders and identified individual perceptions of team psychological safety to be a predictor of entrepreneurial bricolage [58]. This finding suggests that members of problem-solving teams who perceive their team as psychologically safe and are more willing to engage in interpersonal risk taking are better at combining resources to solve new problems. In the current work, we are interested in quantifying founders' ability to identify meaningful resources to mitigate firm-critical obstacles they face. To investigate this relationship, the aim of this study is to answer the following research question:

RQ: How do perceptions of team psychological safety affect the ability of founders to identify meaningful resources?

We added the qualifier "meaningful" to resources to make an important distinction: not all resources are valuable or useful; the value of a resource is derived from the ability of the team to use the resource to overcome an obstacle the team faces. As such, we are interested in *meaningful* resources, or those resources that are most closely related or relevant to obstacles the startup team currently faces. We hypothesize that participants with greater perceptions of team psychological safety will exhibit greater resource management skills. Specifically, we hypothesize that founders with higher levels of perceived psychological safety will be more capable of identifying resources to overcome obstacles because they feel safe taking interpersonal risks on their teams. In fact, increased psychological safety has been linked with greater creativity and risk taking [19], abilities that are instrumental for identifying and utilizing emergent resources.

3. MATERIALS AND METHODS

To investigate the relationship between individual perceptions of team psychological safety and the ability of founders to identify meaningful resources, thirty-two startup company founders were surveyed and interviewed in a mixed-methods research study.

3.1 Participants

Thirty-two (22 male and 10 female) deep-tech startup founders were recruited for this study from ten universities across the Mid-Atlantic Hub of the National Science Foundation's (NSF) Innovation Corps (I-Corps) program. The NSF I-Corps program is a seven-week training program that was founded in 2011, and has trained over 5,000 researchers [59]. The I-Corps program has three main aims: (1) to train the entrepreneurial workforce, (2) to bring cutting-edge technologies to market, and (3) to foster a national innovation ecosystem [60]. It is important to note that these founders are not practitioners; rather, they are university researchers exploring entrepreneurship and the creation of their company. Studying founders from the NSF I-Corps program provides a unique opportunity to investigate authentic problem-solving teams that operate in resource constrained environments. All participants were informed that their participation was voluntary and would not affect their involvement with the NSF I-Corps program in any way; informed consent was obtained in accordance with the Pennsylvania State University's Institutional Review Board policies.

The demographics of the sample with respect to age are shown in Figure 1. The sample's demographics with respect to gender and race are shown in Figure 2. Compared to the general population, this study lacks appropriate representation of women. However, in the context of startup teams, our representation of women (31.25%) aligns well with some of the most startup-oriented ecosystems such as Chicago (30%) and Boston (29%) [61, 62].

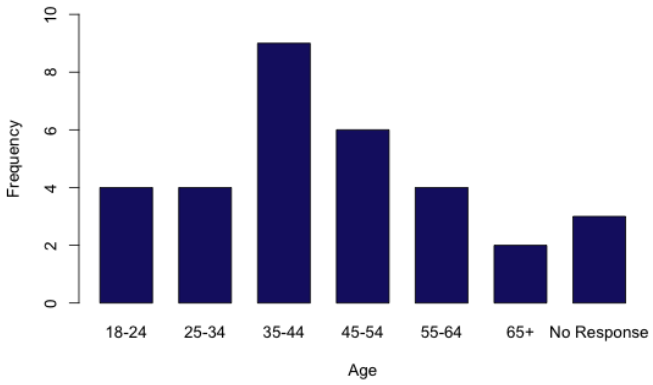

FIGURE 1: DISTRIBUTION OF PARTICIPANTS' AGE

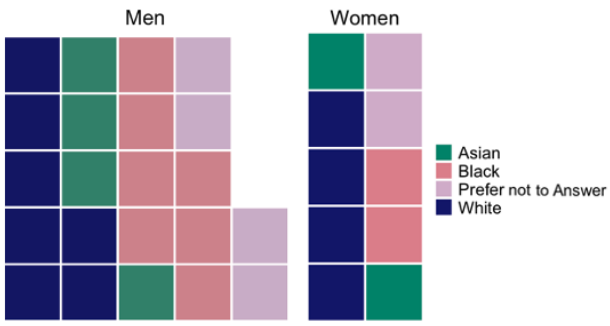

FIGURE 2: DISTRIBUTION OF PARTICIPANTS' RACE AND GENDER

3.2 Data Collection

A survey was created and distributed to participants from the NSF I-Corps program to capture their individual perceptions of psychological safety. At the start of the survey, the participants were informed of the study's purpose and informed consent was obtained.

The survey included the psychological safety scale developed by Edmondson [18], which consists of seven Likert-type items that captured participants' perceptions of the psychological safety of their startup team. Although psychological safety is a team level construct, when using individual scores, Edmondson's scale can be used as a measure of perceptions of psychological safety. Participants rated their agreement with each item on a seven-point scale ranging from 1 (very inaccurate) to 7 (very accurate). A score of 1 represents a low level of perceived psychological safety, while a score of 7 represents a high level of perceived psychological safety. Example items include "*members on this team are able to bring up problems and tough issues*" and "*working with this team, my unique skills and talents are valued and utilized*". Three items on the psychological safety scale used in the survey were worded to portray negative psychological safety. An example of a negatively worded item is "*if you make a mistake on this team, it is often held against you*". These three items were reverse coded to ensure that a low score in response to a negatively worded prompt represents a high level of psychological safety. The overall score for a participant's perceived psychological safety was calculated by taking an average of the participant's scores from each of the seven items.

At the conclusion of the survey, participants were asked if they would be willing to engage in a follow-up interview. The first author then contacted and scheduled interviews with all participants. The first and second authors conducted semi-structured interviews; interviews lasted approximately thirty minutes and were conducted one-on-one via Zoom. During the interviews, participants were first asked to describe their venture, what problem their technology or innovation solves, their primary customer, and the long-term goals of the company. Following these descriptions, the interviewers prompted founders to reflect upon current obstacles their companies face and identify resources they may use to overcome these obstacles. Example questions used during these interviews include:

1. *Please describe any obstacles or hurdles you have faced as a founder.*
    - *How did you manage to overcome these obstacles?*
    - *What resources helped you overcome these obstacles?*
2. *What are the most pressing obstacles that your startup currently faces?*
    - *What plans do you have to mitigate these obstacles?*

All interviews were recorded and audio was transcribed leveraging an automated transcription service. The first author checked all transcriptions for accuracy. Using the interview transcripts, the first and fourth authors qualitatively analyzed the data and employed deductive coding, using a previously developed coding schema by Marcon and Ribeiro [63]. Marcon and Ribeiro identified six categories of resources that foster success and competitive advantage: financial, human, social, organizational, physical, and innovation. Financial resources are often used to acquire other types or resources [64] and are commonly obtained from personal investments, venture capitalists' investments, and accelerators [65]. Human resources, or human capital, can include hiring new employees and training team members to improve their knowledge and necessary skills [66], whereas social resources include intra- and inter-firm relationships [67] from which resources can be shared [68]. Business resources such as the structure of the firm or team and how it conducts work and processes comprise the organizational resource category [69]. Physical resources include materials or equipment related to the necessary technology or product that is being developed [66]. Finally, innovation resources are resources that lead to product development and commercialization [64, 69].

The codebook we used to identify obstacles, shown in Table 1, contains each category of obstacles, along with example statements for each code from our data set. The codebook we used to identify resources, shown in Table 2, contains each category of resources, along with example statements for each code from our data set. The first and third authors met throughout the coding process to discuss the appropriateness of the coding schema for the data and to review the coding process itself. All disagreements in the coding process were discussed and the data was not coded until agreement was reached. Figures 3 and 4

show examples of how obstacles and resources were identified for participants A and B respectively. Red highlight indicates an identified obstacle and green highlight indicates an identified resource. For the purpose of this example, excerpts from the interview were sliced together and extraneous information was omitted.

TABLE 1: CODEBOOK FOR OBSTACLES

Code	Definition	Example
Financial	The monetary ability to develop or implement strategies or acquire other resources [64].	"Funding has been a major obstacle for what we are doing"
Human	Having human capital for articulating strategy deployment [64, 67].	"[I wish I could] hire more people full-time"
Social	Intra- and inter-firm networking relationships [64, 66].	"I would love to have... the ability to have these discussions with partners and stakeholders"
Organizational	The structure of the firm or team and how it conducts work and processes [66, 69].	"There's a lot of nitty-gritty incorporating milestones in terms of licensing... [and] the accounting that comes with running a company"
Physical	The materials or equipment related to the technology or product being developed [66].	"If I had a... prototyping and manufacturing lab, that would be amazing"
Innovation	The ability to develop a new product or process [41].	"The biggest challenges have been understanding how the pharmaceutical markets work"

TABLE 2: CODEBOOK FOR RESOURCES

Code	Definition	Example
Financial	Venture capitalists' investments, family members, accelerators, and founders' capital [64, 65, 70].	"Maryland has programs to provide pre-seed funding, so we have taken advantage of that"
Human	Having the necessary training, experience, intelligence, and insights of team members [66].	"The entrepreneurship and venture programs are pretty good... they helped educate me about how [startups] work"
Social	Sharing resources with actors in their network [68].	"The connections I have made have brought me test sites... and helped me find my first customer"
Organizational	Internal hierarchy and systems within the firm or team [66].	"Technology is delegated, the customer discovery work is delegated, the fundraising is delegated, ... we all communicate together"
Physical	Access to any equipment or facilities for product development [63].	"Pilot scale machines... help us to produce these materials on a large scale"
Innovation	Routines or processes for product development, processes, or services [41, 69].	"We just published an article, detailing the nuances of [our technology]"

"I would say communicating a product… whenever I bring up the technology, it just goes over people's heads. We have been in the process of educating and… we just published an article, just detailing some of the nuances of [our technology]. [On] LinkedIn, I saw a resource [to help educate customers]. We are in the stage of pitching and getting letters of intent signed. That is one of the top [obstacles we are facing]. I would say the others would be getting capital…, equity free capital. I was introduced to the Alex Brown Center for Entrepreneurship… [it has] given me not only just the confidence to go out there and maintain and pitch the concept, but also just the network of people to pitch to. Capital is a huge [obstacle], but you can't get anywhere if you don't have human capital. I've been doing outreach since last week to bring more tech developers on board. So, I had an interview two days ago with [someone], and I'm having one on Friday."

FIGURE 3: EXAMPLE OF PARTICIPANT A'S CODED INTERVIEW

"The most pressing obstacle that I am facing is just funding; it's ongoing. I am looking around to see which [grants] could fit. Right now… talking to different people in my network who were able to put me in contact to do these interviews. I wish I had more information [about business models]. So, I'm at a point, where maybe, I may not know what I need to know. So, having access to someone who can say, 'well, have you thought about A, B, C'."

FIGURE 4: EXAMPLE OF PARTICIPANT B'S CODED INTERVIEW

Once the data set was coded leveraging the obstacle and resource codebooks, we coded for orphaned obstacles, obstacle and resource matches, and extra resources. An orphaned obstacle refers to when a participant identifies an obstacle, but no corresponding resource. An obstacle and resource match refers to when a participant identifies an obstacle along with a resource that can help mitigate that obstacle. Finally, an extra resource refers to any resource the participant identifies that does not correspond to an obstacle. Tables 3 and 4 show how we identified orphaned obstacles (O), obstacle and resource matches (M), and extra resources (R) for participants A and B respectively.

TABLE 3: EXAMPLE OF PARTICIPANT A'S OBSTACLE AND RESOURCE IDENTIFICATION

Obstacle	Resource	Type
Communicating the Product	Published an Article	M
Educating the Customer	LinkedIn	M
Obtaining Letters of Intent	—	O
Equity Free Capital	—	O
Pitching	Alex Brown Center for Entrepreneurship	M
Human Capital	Outreach	M
—	Network	R

TABLE 4: EXAMPLE OF PARTICIPANT B'S OBSTACLE AND RESOURCE IDENTIFICATION

Obstacle	Resource	Type
Funding	—	O
—	Networking	R
Business Model Information	—	O
Wayfinding	—	O

To quantify a participant's resource accuracy, orphaned obstacles were given a weight of -1, obstacle and resource matches were given a weight of +1, and extra resources were given a weight of +0.5. We chose a weight of -1 for orphaned obstacles because having an obstacle with no resources to help mitigate it negatively impacts the team. However, when a resource is identified to mitigate an obstacle, this negative impact is turned positive. Thus, we chose a score of +1 for an obstacle and resource match. Extra resources were weighted +0.5 because while they are helpful, they do not completely mitigate the burden of an unsolved obstacle. The total score for each participant was calculated using the following equation:

$$ResourceAccuracy = -O + M + 0.5R, \quad (1)$$

where O is the number of orphaned obstacles, M is the number of obstacle and resource matches, and R is the number of extra resources. The excerpts shown in Figure 3 and Figure 4 would receive a score of +2.5 and -2.5 respectively.

Prior to understanding the relationship between individual perceptions of psychological safety and the ability to identify resources that mitigate current obstacles, we first provide descriptive information of the types of obstacles and resources that participants identified. Using the codebooks in Table 1 and Table 2, obstacles and resources were organized into six categories: financial, human, social, organizational, physical,

and innovation. Figure 5 shows the frequencies of obstacles and resources identified by the participants for each of the six categories. Obstacles are denoted by the blue bars and resources are denoted by the pink bars. From the interviews with our thirty-two participants, a total of 177 obstacles were identified and a total of 132 resources were identified.

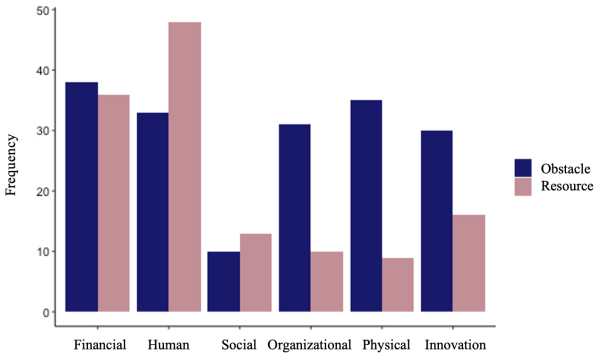

FIGURE 5: FREQUENCY DISTRIBUTION OF OBSTACLES AND RESOURCES THAT PARTICIPANTS IDENTIFIED

4. RESULTS

The statistical analysis was computed using R CRAN v. 4.2.0 at a significance level of $p = 0.05$. Two participants were missing data for their individual perceptions of psychological safety and were removed from this analysis, leaving thirty participants. Figure 6 shows the distribution of participants' average perceived psychological safety (mean = 6.28, sd = 0.77). Figure 7 shows the distribution of participants' resource accuracy score (mean = -0.27, sd = 2.90).

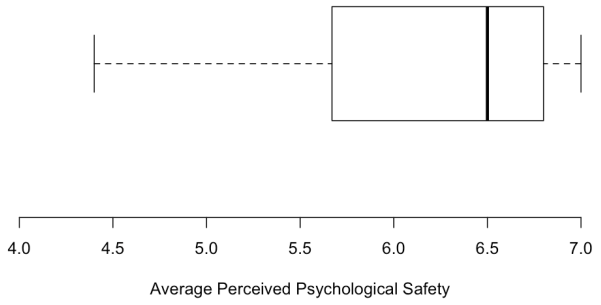

FIGURE 6: DISTRIBUTION OF PARTICIPANTS' AVERAGE PERCEIVED PSYCHOLOGICAL SAFETY SCORES

To answer our research question and to understand the effect of individual perceptions of psychological safety on resource identification, a linear regression was computed with the independent variable being perceptions of psychological safety and the dependent variable being resource accuracy. To assess linearity, a scatterplot of perceptions of psychological safety against resource accuracy with a superimposed regression line was plotted and is shown in Figure 8. Visual inspection of this plot indicated a linear

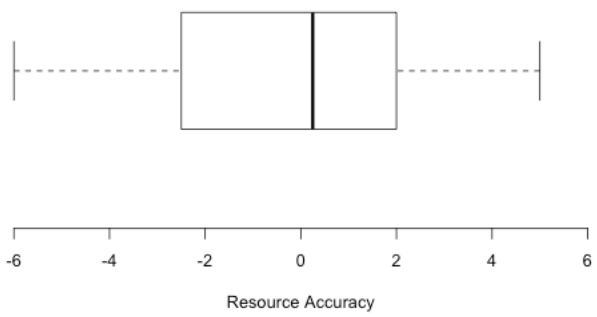

FIGURE 7: DISTRIBUTION OF PARTICIPANTS' RESOURCE ACCURACY SCORES

relationship between the variables. There was homoscedasticity and normality of the residuals. There were no outliers in the data.

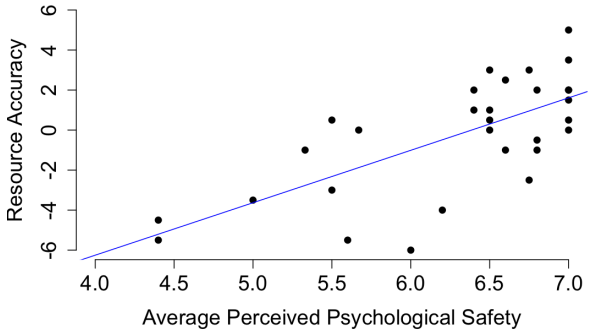

FIGURE 8: SCATTERPLOT OF PERCEPTIONS OF PSYCHOLOGICAL SAFETY AND RESOURCE ACCURACY. THE REGRESSION LINE IS SHOWN IN BLUE.

The prediction equation was: resource accuracy = -16.74 + (2.62*average perceived psychological safety). Perceptions of psychological safety statistically significantly predicted resource accuracy scores, $F(1,29) = 25.92$, $p < 0.001$, accounting for 48.1% of the variation in resource accuracy scores with adjusted R^2 = 46.2%, a moderate effect size according to Cohen [71]. For each 1-point increase in perceptions of psychological safety, there is a 2.62 (95% CI, 1.57 to 3.68) point increase in resource accuracy score.

This finding indicates that perceived psychological safety of teams moderately predicts their resource accuracy. Thus, a founder's perception of the team's feelings of safety for interpersonal risk taking can predict their ability to identify meaningful resources to overcome obstacles they face.

5. DISCUSSION

The main goal of this study was to determine the relationship between team climate and perceptions of obstacles and resources. Team climate was measured by individual perceptions of psychological safety and perceptions of obstacles and resources were measured by resource accuracy. Because limited work has investigated the intersection of these constructs, we sought to understand the practical implications of team climate on resource iden-

tification for authentic problem-solving teams that operate in resource constrained environments. Studying startup founders provides unique and valuable insights to authentic problem-solvers.

The main finding from this study is that individual perceptions of psychological safety predict a greater score for resource accuracy with a moderate R^2 ($R^2 = 0.481$). This finding indicates that individual perceptions of psychological safety moderately predicts resource accuracy. Thus, problem-solvers that perceive their team to be psychologically safe exhibit a greater ability to identify meaningful resources that can mitigate current obstacles. This finding aligns with prior work that has demonstrated that individual perceptions of psychological safety affect founders' ability to engage in entrepreneurial bricolage skills and "create something from nothing" [58]. We hypothesize that problem-solvers that feel safe taking interpersonal risks on their teams are better equipped to more accurately identify and leverage meaningful resources, aligning with prior work which has demonstrated at the firm level the linkages between work climate and resource management [72]. We highlight, however, that little work has investigated the linkages between resource use and team climate at the team level.

We argue that our findings hold significant implications to the field of design due to the parallels between startup and design teams. Both startup teams and design teams often face a scarcity of resources and operate under extreme ambiguity. Further, startup teams are often attempting to bring a product, service, or system to market, and face similar obstacles and milestones as design teams operating within large companies. Our findings suggest that design teams with greater levels of psychological safety may be more capable of identifying resources to overcome perceived obstacles or barriers to the advancement of the design.

6. LIMITATIONS AND FUTURE WORK

One limitation of the current study is that our participants were recruited exclusively from the NSF I-Corps program. Thus, the findings from this study may be affected by self-selection bias. Further, the sample size was relatively small and the participants were geographically clustered in the Mid-Atlantic region of the United States. Prior work has found that geographic location can affect cultural norms and resource availability [73]. As a result, the findings from this work may not be generalizable to broader geographic locations. However, future work will compare these findings to those across the United States.

This work is also limited by psychological safety scores that are greater than expected based on prior literature. For instance, Edmondson's foundational work studying psychological safety in work teams reported a mean value of 5.25 and a standard deviation of 1.03 [18]. However, it is important to note that we studied individual perceptions of psychological safety rather than at the group-level. In fact, our data aligns well with recent work studying the effects of teaming interventions on engineering design students' individual perceptions of psychological safety. In this study, Scarpinella et al. [53] reported a mean perceived psychological safety of 6.08 in their control group and 6.39 in their intervention group. Future work should investigate the potential effects of lower perceptions of psychological safety.

The findings from our work indicate that perceptions of psychological safety affect perceptions of obstacles and resources in teams. Yassine and Naoum-Sawaya [74] developed a modeling tool to allocate scarce resources in the context of architectural design. One major area of future work could focus on integrating factors that may affect resource management, such as psychological safety, into such models to develop a more holistic resource management strategy for teams and firms.

7. CONCLUSION

We sought to understand how problem-solvers' perceptions of team climate—measured by perceptions of psychological safety—affect their ability to identify meaningful resources—measured by the resource accuracy. To achieve this goal, a mixed-methods study was conducted on thirty-two startup company founders that participated in the Mid-Atlantic Hub of the NSF I-Corps program. These founders provide a unique opportunity to study authentic problem-solvers that operate in a resource constrained environment, similar to engineering design. Founders were surveyed on their individual perceptions of psychological safety and were interviewed to determine their ability to identify meaningful resources. To determine how accurately founders can identify meaningful resources, we must first understand the obstacles they face; founders identified obstacles and resources in the following categories: financial, human, social, organizational, physical, and innovation. Results suggest that individual perceptions of psychological safety predict founders' ability to identify meaningful resources. In order to understand how problem-solvers operate, we aimed to uncover how their perceptions of team climate affect their ability to identify meaningful resources. Understanding how team climate affects the problem-solving process provides critical insights to the process itself. If we can understand this relationship, teams can work to foster greater levels of psychological safety that can positively affect their team outcomes.

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