ETM
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Does Size Matter?

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ABSTRACT

From early research to more recent models of team effectiveness, team size has been considered an important structural variable determining team processes. Although so much time has passed, the question “how does team size affect the performance of teams in various projects?” is still relevant. For the purpose of this research, findings of an expert focus group will be compared against the existing literature to see any gaps or inconsistencies that may be present. Future research will be suggested based on this comparison.

I. INTRODUCTION

Jeff Bezos has a rule at Amazon, or perhaps a philosophy: *"If a team cannot be fed by two pizzas then it is too large"*[1]. From early research to more recent models of team effectiveness, team size has been considered an important structural variable determining team processes (e.g. team collaboration, social loafing, etc.) and, subsequently, team performance (i.e., the effectiveness and efficiency of task completion). The reasoning is quite straight forward and basic. More people means more communication, more bureaucracy, more chaos, and more of pretty much everything that slows things down, hence why large organizations are often times pegged as being so inefficient.

II. RESEARCH QUESTION

How exactly does team size affect the performance of the team in managing projects? Although the question we are asking seems quite simple, findings of literature review in combination with our experiences suggest the answer may not be that simple. Although small teams seem to perform better in some instances, obviously there are projects which require large teams or cases where large teams just perform better. We will try to find answers to this dilemma both from literature and empirical perspectives.

III. LITERATURE REVIEW

When thinking about team size, one of the first things to consider is communication. PMI gives the number of communication channels for "n" number of stakeholders as n*(n-1)/2[2]; which is a good indication of size of communication complexity in general terms. This means as team size double from 6 to 12, communication complexity increases more than 4 times! The geometric growth of communication size can be seen in Figure 1.

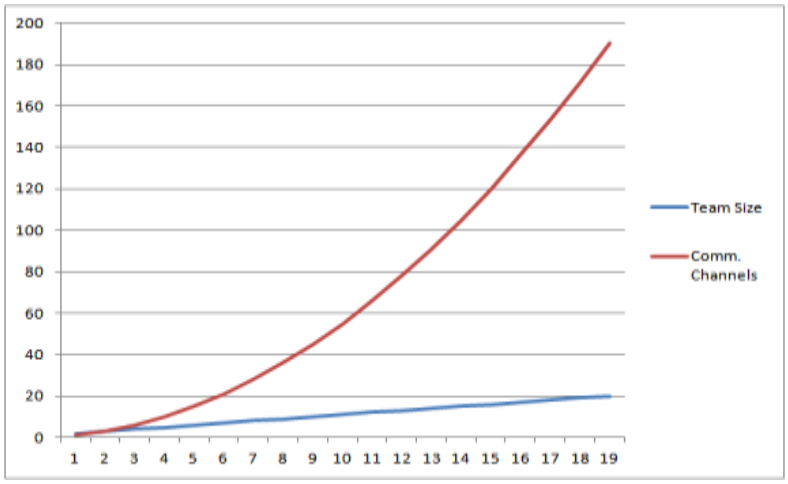

Figure 1 - Communication complexity with respect to number of team members

And of course right after communication, people think about workload. Although it may be guessed at first that work can easily be distributed evenly, Brooks Law classifies project tasks in either of 4 groups as: (i) perfectly partitionable task, (ii) non-partitionable task, (iii) partitionable task requiring communication and (iv) task with complex interrelationships[3]. It is argued in the same paper that most tasks in software engineering belong to the last category, task with complex interrelationships. These relationships between effort and team size are summarized in Figure 2.

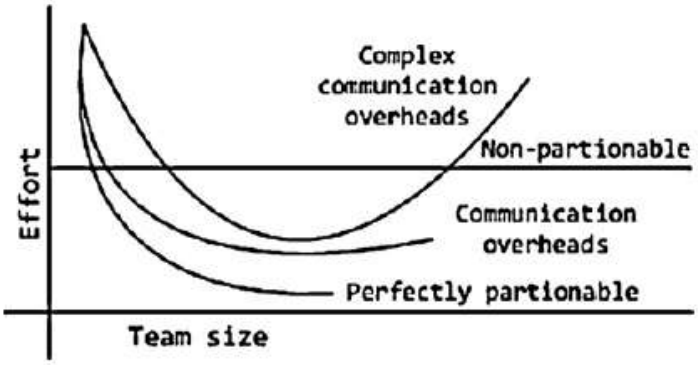

Figure 2 – Team size vs. effort according to Brooks' tasks classification[4]

Communication overheads also increase as the number of people increases. Due to combinatorial explosion, the number of different communication channels increases rapidly with the number of people. Everyone working on the same task needs to keep in sync, so as more people are added they spend more time trying to find out what everyone else is doing.

Research has shown that although increasing a team's size has many benefits such as increased specialization and expanded knowledge networks, the team's actual productivity may decline due to the process[5][6]. Increasing a team's size result in coordination issues, individual or collective member motivational decline, and increased conflicts among the team[7][8][9].

The relationship between size of the team and workload is not limited to this. According to a concept known as team scaling fallacy, as team size grows, a tendency to underestimate task completion time does so as well[10]. Another reason why people may correlate the increasing in team size to diminishing returns is the underestimation of the additional time required to coordinate team members' efforts. This is called coordination neglect[11], which occurs when estimators focus more on efficiency of the dividing responsibility for project components among team members than they do to the time required to integrate and coordinate that work. As the group grows and the work gets divided the integration complexity also grows. The estimate of integrating completed work among the complex divisions becomes increasingly difficult[10].

Additionally, managerial effectiveness and accountability remain a strong focus of organizational scrutiny. Finding the right balance of employees to managers - called span of control or management ratio[12] can be critical and challenging. Wider span of control or large team size means less administrative expense and more self management- both very popular goals in a down economy. Advances in technology and changes in organizational structure, along with market pressures are currently driving an increase in the number of employees managers supervise. Given the current economy however, this upward trend is likely to continue. A median management ratio is found as 1 to 16 in the healthcare sector, but only 1 to 4 in information services [12]. Investigating further, the average span of control in the corporate sector was found as 1 to 11 for service companies and 1 to 9 for all business sectors combined in a Wall Street Journal study seven years ago, which suggests these standards vary both by industry and company size [13].

Classic experiments by German psychologist Ringelmann at the beginning of the 20th century first documented a steep decrease of effort in men engaged in a tug of war [14]. It is found that individuals decrease their effort as the number of people in the group increases, which is defined as the social loafing phenomenon. Later experiments demonstrated that this loss in performance is, in fact, due to decreased effort, rather than coordination losses or other possible

causes [15]. Similarly it was found that, as the size of problem-solving teams increases, so does the number of nonparticipating members [16]. This term refers to individuals that do not actively participate in the team's collaborative work. Bray et al. coin the term functional size, referring to those individuals that are contributing to the team's work. This illustrates that, as team size increases, it becomes more difficult for team members to contribute their knowledge, skills, and experience to their full potential, thus hindering an essential element of teamwork quality, i.e., the balance of member contributions [17].

Even further research elaborates this, where the concept of "relational loss" is introduced [18]. This concept describes individuals' feels as though the amount of support they get from others decreases as the size of the team increases. This is a very common feeling inside many organizations. Relational loss specifically involve perceptions about the extent to which teammates are likely to provide help, assistance, and support in the face of struggle or difficulty [19][20][21]. Relational loss can involve the perceived availability of four types of support including: emotional support (the expression of trust and positive emotion to teammates in the context of setbacks or struggle), instrumental support (help and assistance from teammates), appraisal support (advice to help teammates overcome setbacks), and informational support (information to help members solve problems.

IV. Research Framework

Simply put, the framework of our research is to investigate how our experiences align alongside the findings of the literature review. Research is designed to follow the methodology given as:

1. Define the "team size" and "team performance"
2. Expert judgment: Identify how team size affect team performance based on experience (acting as the focus group)
3. Compare expert judgment to finding of literature review
4. Discuss the results of this comparison
5. Identify future research topics based on gaps or misalignment between the expert judgment and existing literature

We all worked with groups with lots of members, but how do we define number of team members among these groups? Our expert definition of the team members is "the minimum number of people that must be present within the group to decide on how to proceed with the project". For example we may have more than 20 people working in our cross functional project team but 1 representative from each department is required to reach census, so the team size may be just 6 in this case with the rest of the group (14 people) considered as the "background personnel". And for team performance we considered the teams we found to be successful, efficient and satisfying in achieving the project goals.

As the writers of the paper, we have experience covering a wide range of industries: From construction to aerospace, software to semiconductors. Acting as subject matter experts we developed a framework for the usefulness of the size of the group with respect to team performance. We define a small team as 2 to 8 people and large team as 9 to 20 people. Groups of 21 people and above are not considered as teams, but as working groups or organizations without team structure; therefore discarded.

V. Empirical Findings

Clearing out the definitions of team size and performance, the findings of our focus group

regarding the relationship between team size and performance are given in Table 1.

Small Teams (2-6 people)	**Large Teams (9-20 people)**
Easy communication	Less workload
Easy decision making	More ideas
Easy to visualize the effect of each individual's role in the team goal	Easy to compensate for missing team member(s)
Shorter, more efficient meetings	Complex tasks can be handled
Easier cohesion, stronger trust	Less dependability to others' work
Easy to colocate all members	A more structured standardization
Motivation from individual contributions	Pop-up tasks can be handled easier
Gossiping is not a big problem	
Less competition in some cases	

Table 1 - Advantages of small and large teams compared

First 2 rows in above table are the most obvious contrasts. As the team grows larger in size, workload of each member usually becomes smaller; however the communication requirements grow geometrically. Similarly, more ideas usually emerge from larges teams, while it becomes much harder to reach a consensus.

One of the cases where team size makes the most difference is when trying to make use of agile project management methodologies (usually in software development) where a quick response to any change in the project definition is essential. That responsiveness called "agility" is often provided by means of short but frequent meetings. Also co-location, quick decision making and high motivation are key for implementation. One of the most popular sources for agile methodologies [22] clearly puts the size of an agile software development between 3 and 9, so any large team is out of question.

Then again sometimes in hardware development projects, there are complex tasks which can't be broken down into individually meaningful tasks that can be handled by less than 9 people, which require a large team by definition. This is sometimes due to different areas of expertise required and sometimes due to workload required to fulfill that task. There is also a team size determining concept called "coupling" which is defined as the establishment of links between entities of the sub-domains while preserving their original objective. Higher the degree of coupling, it would be better to have a smaller team working on different subdomains of the project. But with lesser degree of coupling, it would make sense to have a larger team working on different sub-domains parallel resulting in early completion of project.

Also in smaller teams, individual contributions to the common goal become more visible. This makes motivation from individual contributions, as well as the burden of less-contributing members higher. All through the work done for the projects, there emerge temporary absence of team members. Whether due to sickness, or their other duties within the organization, or leaving the company, or any other reason, larger teams compensate much easier for the temporary absence or new addition of team members.

While the dependency to other team members' work becomes less significant in this way,

it also affects the institution of trust among members in a large team. Team members become much closer in small teams which greatly increase cohesion and trust. As team grows in size, team members start to have less interaction which tend to make them more “distant” to one another. This may lead to “communication cooties” such as gossiping or talking behind the backs of others. Constructive feedback will be severely impacted in such cases.

At times, the total workload of team may also change as the project advances. This may be due to changes in scope, as well as any pop-up tasks which were not foreseen in the initial project planning. Larger teams tend to handle these additional tasks much easier compared to smaller teams since new tasks are distributed with less “delta work” required per team member.

Team size may also have considerable impact in some of the team’s appraisal and rewarding systems like Bell Curve Performance Management [23], (see Figure 3).

Figure 3 – Bell Curve performance review method

The normal distribution of this systematic bell-shaped graph places the majority of people in the average performance area while keeping the exceptions on both sides of the dropping slope. We have seen that that as the team size increases, the competition to excel and become top performers increases within the team, negatively affecting the common interests and goals of the team. This would often lead to insecurity, dissatisfaction and the average performers are left demotivated to work within the team.

Lastly, considering healthy organizations, larger teams require a better and stronger organizational structure to handle efficiently. This leads to a more standardized team building and task distribution practices which eventually strengthen the organizational process assets of the company.

VI. RESULTS & DISCUSSION

Initial findings indicated that there is an inverse relationship between team size and team performance in management teams. It was also indicated that more number of members in the team disrupts team processes and gets in the way of benefits. As a result, large teams struggle to function as a unit and perform worse by failing to build team cohesion; just as our initial empirical findings demonstrated. Team cohesion is the primary requirement which creates a better understanding of how other team members think and feel thus prevents misunderstanding and conflicts. In a large team, a decrease in team cohesion may therefore lead to more relationship conflicts. In large team communication also becomes restricted which affects free flowing conversations necessary for creative ideas. Our other findings relating size and performance in negative way are explained in the literature as Ringelmann Effect, loss of motivation, social

loafing and coordination problems.

One of the other phenomenon observed in several construction projects as the need for increased crew size is required, was detailed in the literature as scaling fallacy. The estimated labor hours for the assigned tasks are exceeded as the crew size grows beyond what was budgeted. Although the tasks for the phase can be divided among more team members, depending on their rank and pay scale, the increase in labor diminish the budget for the phase at an increased rate, resulting in an a loss of funds that has been allotted to serve other phases of the project. Budgeted time can be molded to fit the right ranks of crew members such as the ratio of apprentices to journeymen in the field. However as the skill level is parallel to the labor cost as it decreases from journeyman to apprentices the number of field foreman whose rate is above journeyman is required proportionally to the number of apprentices. Depending on the level of experience within the teams additional time to understand how to complete the tasks efficiently and effectively may be required. If this is the case the field foreman must spend more time coordinating efforts. Above this the general foreman may need to step in to help coordinate, which will incurring additional hours and labor costs to the phase of the project. These additional requirements are rarely taken into account accurately during the estimating phase of the project before any productive labor starts. The estimator's goal is to budget the project assuming that the crew is of efficient size and crew member ratio of experience is maximized. This is a common error early on in the projects that is hard to predict and is an example of coordination neglect as mentioned in the literature review.

Although bigger team has its perks of having variety of ideas for the project, one of the biggest drawback which has been experienced is its ability to maintain a proper coordination and establishing an understanding among team mates. As explained in the literature, with more people, the ability to approach a problem can be determined easily, however, it can also raise chances of conflicts and misunderstandings among team members in bigger group setting. This also cause delay in completion of the project and also communication breakdown. Whereas, with smaller teams, once the process has been established, it is easier to coordinate and balance out work load with one another which not only help bring projects to successful completion, but also increases the trust and synergy among team mates.

Additionally, supporting the previous point, another paper provides an excellent example with its numerical data that individual efforts and motivational factor on the project in a bigger team is much lower compared to smaller team. Bigger the group, lesser the workload, but it can also create imbalance with workload as the reliability on other increases which leads to lack of motivation to accomplish the task. Whereas, in a smaller group setting, every individual has equally allocated work; therefore, loss in performance and coordination is minimal to none. This explains the better translation of individual effort to team goals in smaller teams.

The fact that having to sustain larger teams would drive organizations to have better structures and procedures, span of control concept demonstrates this relation. Referring to the concept of span of control, there comes the question how many employees within a team can a manager handle. Typically, span of control is either narrow or wide resulting in a flatter or more hierarchical organizational structure. Each type has its inherent advantages and disadvantages as we have experienced. Considering the narrow span of control or smaller teams, managers can spend time with employees and supervise them more closely which would help to create more development, growth, and advancement opportunities. In case of a wider span of control or bigger team which has fewer levels of reporting in the organization, resulting in a more flexible, flatter

organization. This also encourages empowerment of team members by giving more responsibility, delegation and decision-making power to achieve the desired team performance. Several researchers have tried to understand the optimal span of control and we also think that organization size, nature of an organization and Industry size might have an impact on deciding the optimum span of control.

Drawing from the literature on stress and coping, relational loss, a unique form of individual level process, loss occurs when an employee perceives that support is less available in the team as team size increases. Individuals start experiencing lower levels of coordination and motivation, thus negatively impacting the performance. We have also observed this individual behavior in our personal experiences, where certain team members with high EQ and high steadiness find it difficult to work with the larger teams. They always look for a psychological supportive climate which reflects an employee's perception that teammates provide caring and help to one another. We agree that certain individuals might experience this feeling in larger teams, but on the other hand we believe that larger teams have more potential productivity that can lead organizations to increased competitive advantage if managed correctly. Effective team management and monitoring can reduce the effect of relational loss and helps the team perform better.

VI. Conclusion

In conclusion we can see that there is no simple answer to how team size affects performance. What is certain is that, size of the teams directly affect team performance. Although most of the time, team performance declines as the teams grow, there are few cases where the effect is positively proportional as well. Most of our empirical findings regarding our experiences align quite nicely alongside the literature, supporting academic findings most of the time. As expected, there are some exceptions and gaps as well. Although some of them can be argued to be too case specific, rest can be addressed with future research.

VII. Future Research

By taking into consideration the interactions of positive and negative effects of team size on team performance, our research found that most of the time, there is a tendency for team performance to decrease as team size increased which was also backed-up by the literature. However, more research should be done in order to understand the size-performance association in more depth and be able to predict when and why team size has strong negative effect on team performance. There are some figures regarding ideal team size for some industries in the literature (i.e. software development, healthcare, service industry), however it is still far behind covering all industries.

We have not touched much upon the emotional/organization behavior. Though we came across many research papers studying the effect of team size on individual's performance and behavior, a clear cut conclusion could not be drawn from it. We think this would be a good follow-on research in this field can help the team to optimize their team size with happy and high-performing individuals within the team. Some research can also be done on how some factors like motivation, team cohesion, trust, etc. can work as a mediator and help large teams to improve their performance, which is actually out of scope of this discussion.

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