On the Sizes of Groups Using the Full and Optimized EPMcreate Creativity Enhancement Technique for Web Site Requirements Elicitation

by

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Introduction

Creativity is often needed in requirements elicitation, e.g., in generating ideas for requirements.

Techniques to enhance creativity are believed to be useful.

In our research, we have been investigating EPMcreate (EPM Creative Requirements Engineering [A] TEchnique), which is based on the Elementary Pragmatic Model (EPM) of the pragmatics of communication.

Acronyms to Save Space in Slides

RElic = requirements elicitation

RA = requirements analyst or engineer

CET = creativity enhancement technique

BS = brainstorming

EPMcreate

EPMcreate supports idea generation in RElic by focusing the RA's search for ideas on only one logical combination of two stakeholders' viewpoints at a time.

16 combinations are possible, corresponding to the 16 basic boolean functions, *fi* for $0 \leq i \leq 15$, of two variables.

16 Boolean Functions of 2 Variables

*V*1	*V*2	*f*0	*f*1	*f*2	*f*3	*f*4	*f*5	*f*6	*f*7
0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	1	1	1	1
1	0	0	0	1	1	0	0	1	1
1	1	0	1	0	1	0	1	0	1

*V*1	*V*2	*f*8	*f*9	*f*10	*f*11	*f*12	*f*13	*f*14	*f*15
0	0	1	1	1	1	1	1	1	1
0	1	0	0	0	0	1	1	1	1
1	0	0	0	1	1	0	0	1	1
1	1	0	1	0	1	0	1	0	1

EPMcreate in Practice

EPMcreate can be used whenever idea generation is needed during RElic.

When a lead RA determines that EPMcreate should be applied during RElic for the system being built, …

EPMcreate in Practice, Cont'd

she chooses 2 kinds of stakeholders, *SH*1 and *SH*2, usually users of the system with different roles.

E.g., the selected stakeholder types could be

- **students and lecturers for an e-learning application, and**
- **employees of the selling and buying companies for a system supporting a company's B2B activities.**

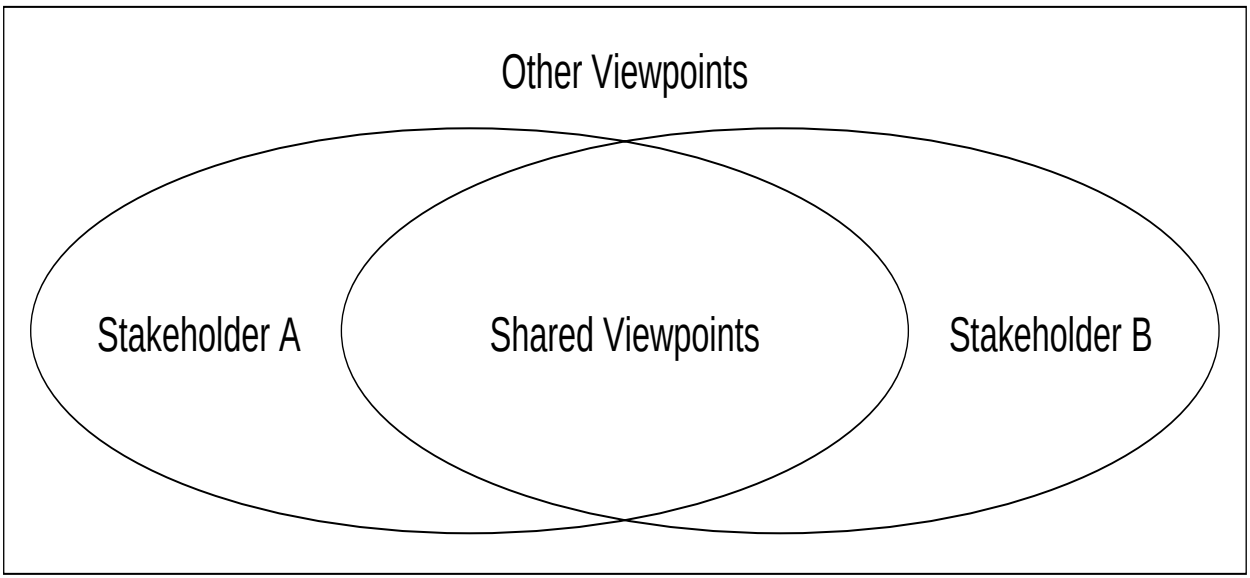
EPMcreate in Practice, Cont'd

Normally, not all pairs of stakeholder types are used.

The lead RA chooses pairs she believes to be informative.

She then convenes a group of RAs and shows them the Venn Diagram on the next slide.

Venn Diagram of Viewpoints



The two ellipses represent 2 stakeholders' viewpoints.

Instructions given to RAs

The lead RA tells all convened RAs:

“Today, we are going to generate requirement ideas for the system *S* in 16 idea generation steps. In all the steps, you will be pretending to think from the viewpoints of two particular stakeholders of *S*, *SH*1 and *SH*2.

Step 0, for $f0 = \mathbf{0}$

In Step 0, you will blank out your minds.

Step 1, for $f1 = \boldsymbol{SH1} \wedge \boldsymbol{SH2}$

In Step 1, you will try to come up with ideas for problem solutions that are needed by both *SH*1 and *SH*2.

Step 2, for $f2 = SH1 \wedge \neg SH2$

In Step 2, you will try to come up with ideas for problem solutions that are needed by *SH*1 but not by *SH*2.

Step 3, for $f3 = SH1$

In Step 3, you will try to come up with ideas for problem solutions that are needed by *SH*1 without concern as to whether they are needed by *SH*2.

Step 4, for $f4 = \neg SH1 \wedge SH2$

In Step 4, you will try to come up with ideas for problem solutions that are needed by *SH2* but not by *SH1*.

Step 5, for $f5 = SH2$

In Step 5, you will try to come up with ideas for problem solutions that are needed by *SH2* without concern as to whether they are needed by *SH1*.

…

Step 8, for $f8 = \neg SH1 \wedge \neg SH2$

In Step 8, you will try to come up with ideas for problem solutions that are needed neither by *SH*1 nor by *SH*2, but are needed by other stakeholders.

…

Step 10, for $f10 = \neg$ ***SH2***

In Step 10, you will try to come up with ideas for problem solutions that are not needed by *SH2* without concern as to whether they are needed by *SH*1.

…

Step 15, for $f15 = 1$

In Step 15, you will try to come up with ideas for problem solutions without concern as to whether they are needed by either *SH*1 or *SH*2.”

Optimization, POEPMcreate

We demonstrated in experiments that one optimization of EPMcreate, the Power-Only EPMcreate (POEPMcreate), is more efficient in supporting idea generation for RElic.

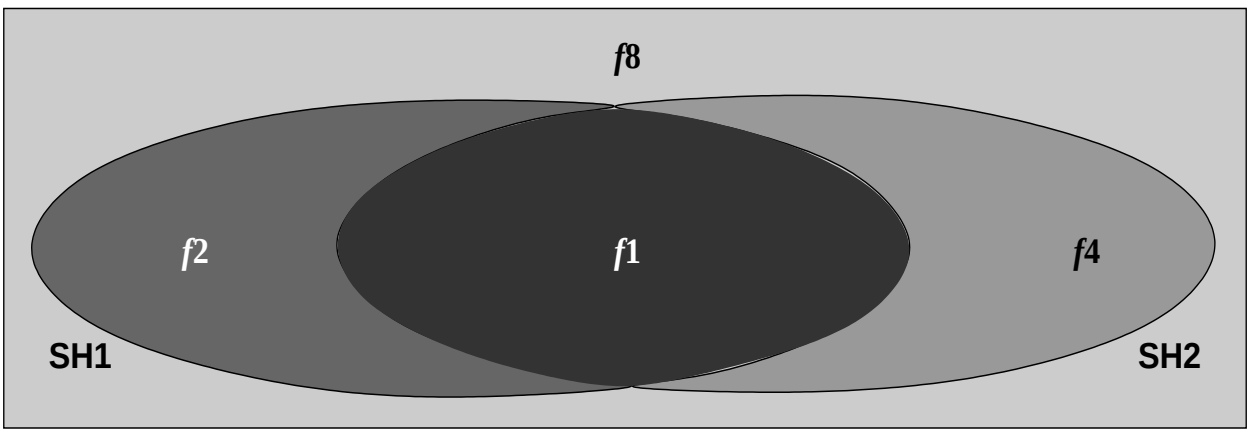
POEPMcreate does only the 4 steps whose names include the powers of 2, namely Steps 1, 2, 4, and 8.

“more efficient” means that more and better ideas are generated in the same amount of time.

Why More Efficient?

As shown below,

$f1 = SH1 \wedge SH2$ $f2 = SH1 \wedge \neg SH2$ $f4 = \neg SH1 \wedge SH2$ $f8 = \neg SH1 \wedge \neg SH2$



Why, Cont'd

the Boolean function of each of the power-of-2 steps corresponds to exactly one of the four regions of the Venn Diagram shown before.

Thus, the 4 power-of-2 steps suffice to cover the entire space of potential ideas, …

and the other 12 steps just repeat the coverage.

EPMcreate's Effectiveness

We have conducted controlled experiments which used an online course system, an e-government system, the Website of a jazz festival, and the Website of a Canadian high school as the systems about which to elicit requirement ideas.

Notation in the Results

In the following, "*A* ≥ *B*" ≡ "*A* is more effective than *B* in helping to generate requirement ideas, measured by numbers of both raw (quantity) ideas and innovative, useful (quality) ideas".

Controlled Experiment Results

These controlled experiments concluded with statistically significant results that

EPMcreate ≥ BS

and

POEPMcreate ≥ EPMcreate.

Research Question

Does the number of members of an elicitation group using EPMcreate or POEPMcreate as a CET affect the number of requirement ideas generated by the group and by each member?

When we started, we really had no idea about the answer.

So we started with null hypotheses.

Hypotheses

H1 **In each of EPMcreate and POEPMcreate, the number of members of an elicitation group has no effect on the quantity and quality of the requirement ideas generated *by the group*.**

H2 **In each of EPMcreate and POEPMcreate, the number of members of an elicitation group has no effect on the quantity and quality of the requirement ideas generated *on average by each member of the group*.**

Method

We combined the data of a number of identically structured experiments in which individuals and groups of size 2 and 4 used EPMcreate and POEPMcreate to generate ideas for requirements for enhancing one Canadian high school's Website.

Method, Cont'd

Later, for triangulation, we conducted a survey to determine software development practitioners' attitudes on the comparison of the effectiveness of individuals and groups in requirements elicitation for real projects.

Results of the Experiments

The next two slides show graphs of the data of the combined experiments:

1. **the number of raw and new requirements ideas generated by entire groups, and**

2. **the number of raw and new requirements ideas generated *on average* by each member of groups.**

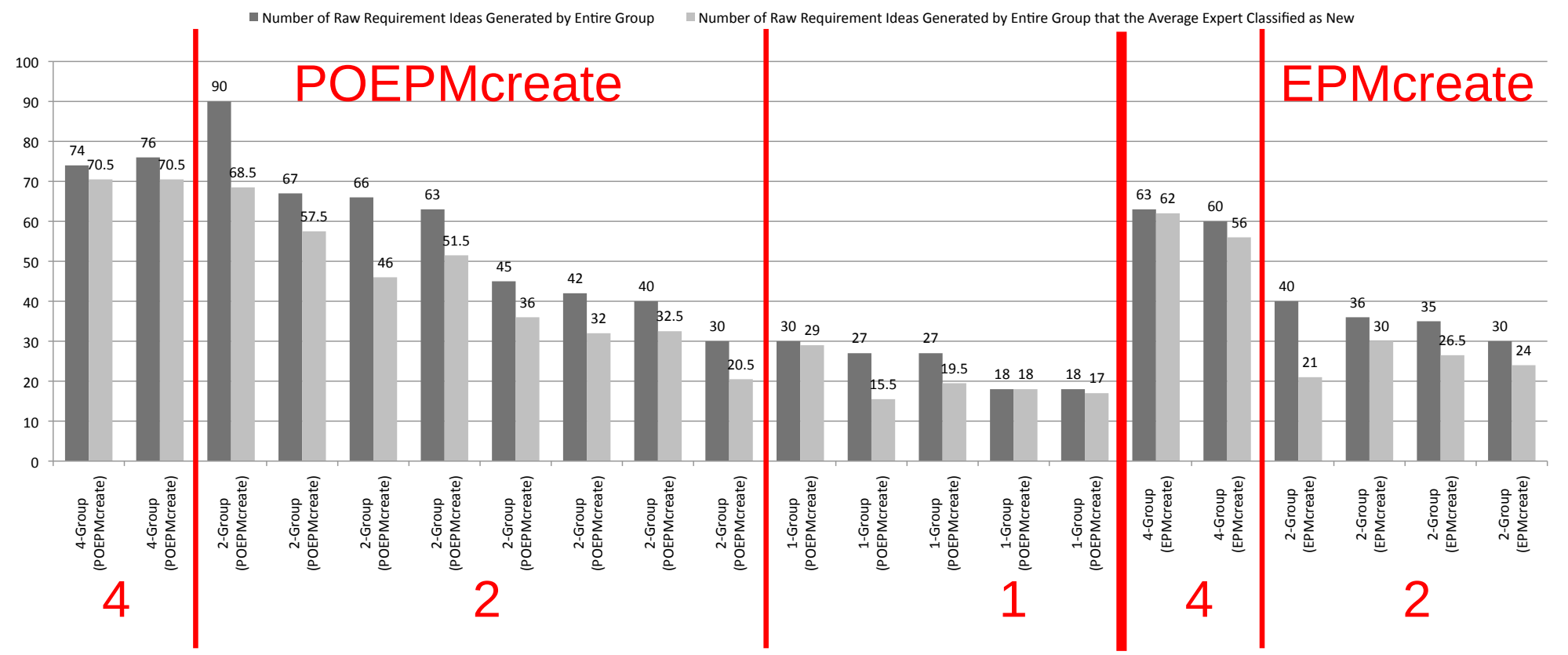


Fig. 4. Number of Raw and New Requirements Ideas Generated by Entire Groups

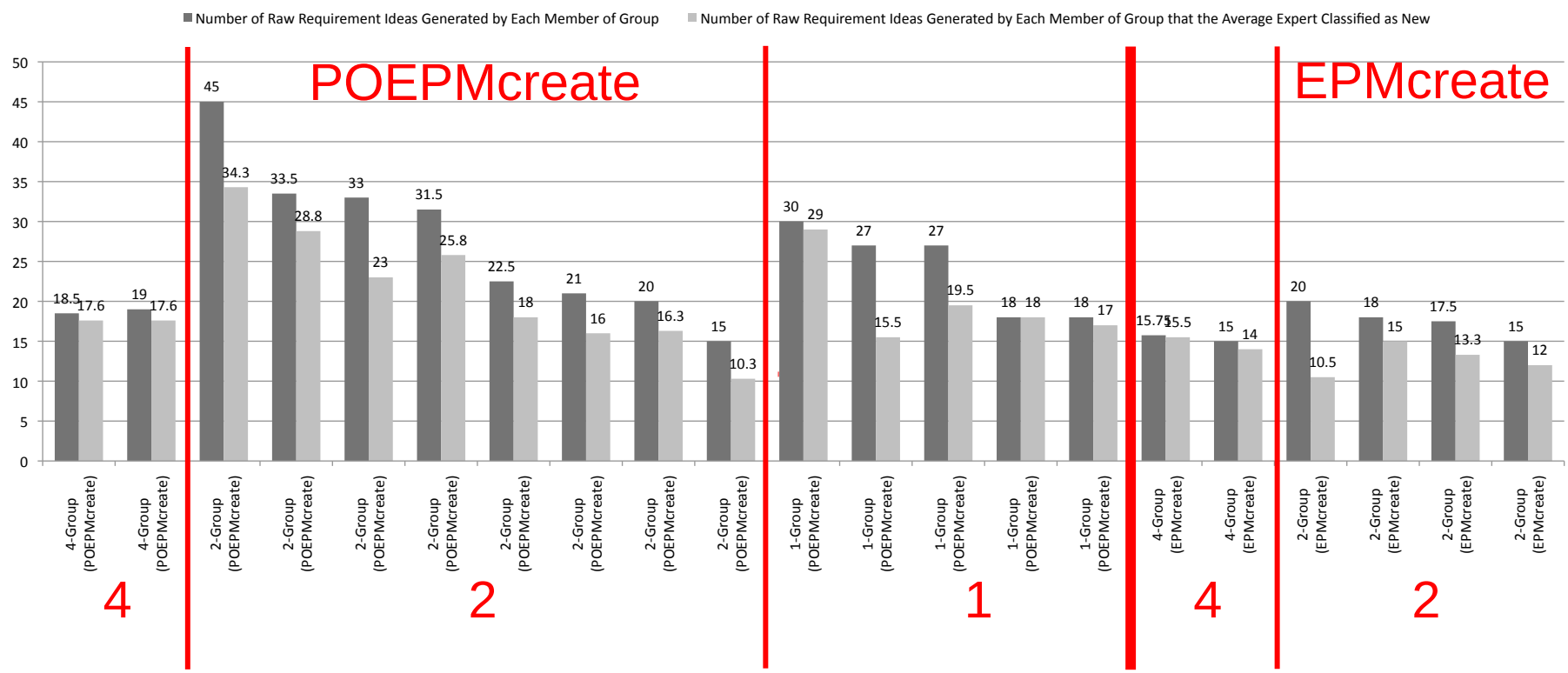


Fig. 5. Number of Raw and New Requirements Ideas Generated by Each Member of Groups

Refined Hypotheses

H1 and H2 are refined into 8 subhypotheses, HETR, HETN, HEAR, HEAN, HPTR, HPTN, HPAR, and HPAN:

The number of members of an elicitation group using { ***E*: EPMcreate** ; ***P*: POEPMcreate** } **has no effect on the** { ***T*: total number of ideas per group** ; ***A*: average number of ideas per group member** } **of** { ***R*: raw** ; ***N*: new** } **requirement ideas generated.**

Summary of Conclusions

The table on the next slide summarizes the conclusions about the subhypotheses that are drawn from the data, …

giving in for each subhypothesis,

- **whether**
- **how strongly, and**
- **why**

it is rejected.

CET	compared group sizes	H1 # of req ideas generated by whole group **TR**	Res #	H1 # of new req ideas generated by whole group **TN**	Res #	H2 # of req ideas generated on avg. by group member **AR**	Res #	H2 # of new req ideas generated on avg. by group member **AN**	Res #
EPMcreate	4 & 2	HETR REJECT $4 > 2$	1	HETN **REJECT** $4 > 2$	8	HEAR reject SIGNIFICANT $2 > 4$	2 3	HEAN reject INSIGNIFICANT $2 \approx 4$ cannot reject	9 10
POEPMcreate	4 & 2	HPTR Reject $4 > 2$	4	HPTR REJECT $4 > 2$	11	HPAR barely SIGNIFICANT $2 > 4$	5 6	HPAN hardly INSIGNIFICANT $2 \approx 4$ significant $2 > 4$	12 13 13
	2 & 1	HPTR Reject $2 > 1$	4	HPTN REJECT $2 > 1$	11	HPAR barely INSIGNIFICANT $2 \approx 1$ cannot reject	5 7	HPAN hardly INSIGNIFICANT $2 \approx 1$ cannot reject	12 14

In Other Words

It appears that the size of a group using EPMcreate and POEPMcreate *does* affect the number of raw and new requirement ideas generated by the group and by each member of the group.

The larger a group is, the more raw and new requirement ideas it generates.

However, the smaller a group is, the more raw and new requirement ideas the average of its members generates.

Triangulation

The survey results, shown on the next slide, indicate that experienced software development practitioners have observed the same and seem to act accordingly.

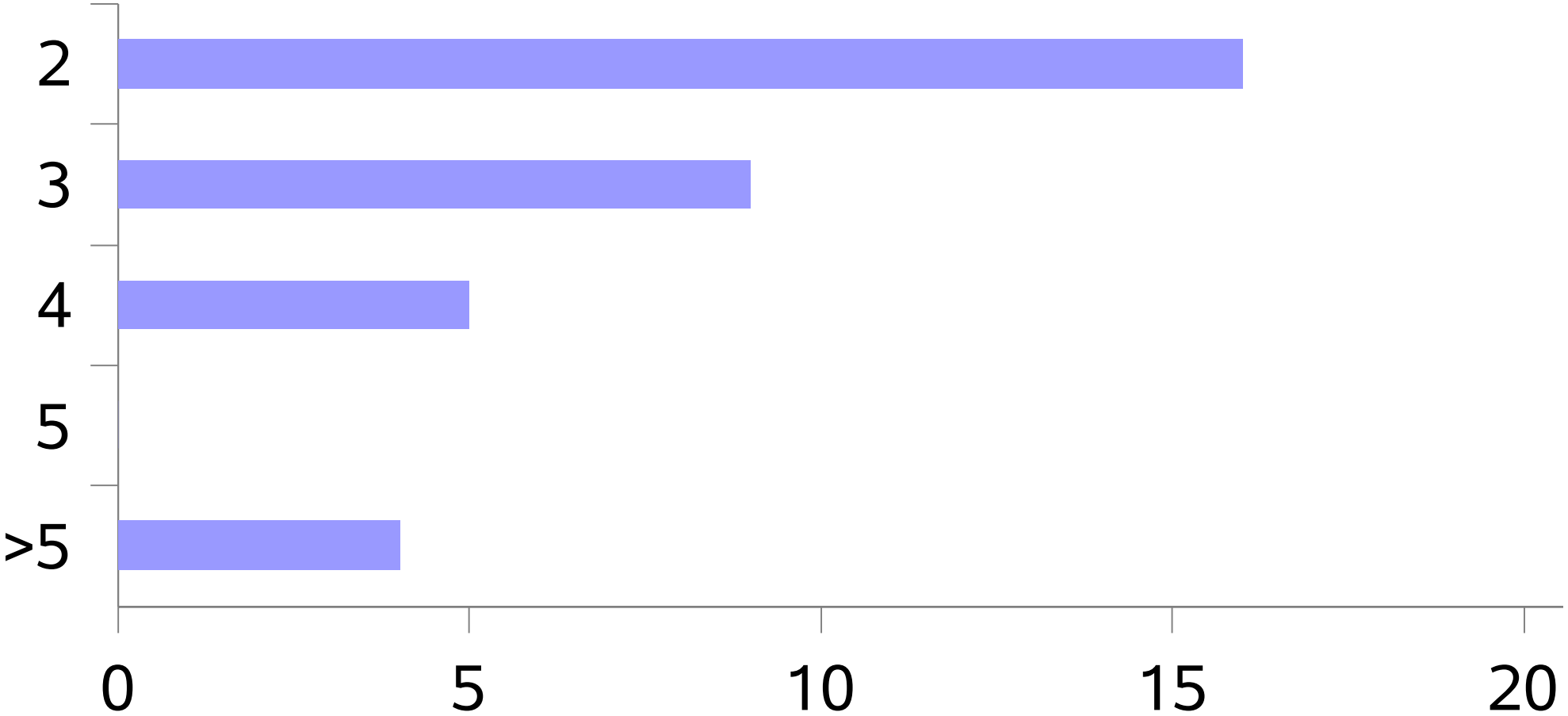


Fig. 6. Sizes of Ideal Groups of Business or Requirements Analysts

Speculation

We observed that for POEPMcreate,

- **a 4-person group generates on average 75 raw requirement ideas, 18.75 per member, but**

- **a 2-person group generates on average 55.38 raw requirement ideas, 27.69 per member.**

Best Use of a Set of Analysts

So, if you have 4 analysts, …

maybe it's better to have

two independent 2-person groups generating 110.76 ideas

than

one 4-person group generating 75 ideas.

Duplicated Ideas?

What about the duplicated ideas between the two independent 2-person groups?

We tested the duplication of ideas among pairs of groups and found it to be uniformly less than 110.76 – 75 = 35.76!

Wow!!

Future Work

More experiments to increase and balance the numbers of each size of group, to try

- **to confirm and strengthen these results and**
- **to answer the speculation.**

More survey data for better triangulation.

Now Read Our Paper!

I hope that we have gotten you excited enough that you will now go and read our paper!