

Using Multiteam Systems Theory and TeamWork Quality to Identify Influence Factors for Measuring the Performance of Agile Teams in Large-Scale Agile Development

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1. Introduction

- Motivation
- Problem Statement
- Research Questions
- Research Approach

2. Influence Factors

- Agile and Large-Scaled Agile
- Multiteam-Systems (MTS)

3. Survey Results

- Structure
- Survey Data Analysis and Processing
- Hypotheses Results
- TWQ on Program-Level (PWQ)

Motivation - Large-Scale Agile Development

1

Agile has replaced the waterfall model in software development

Google Trend: **10 times** more people search for “agile” compared to traditional project management methods [1]

2

More and more big projects and companies adapt Large-Scale Agile development

29% of the companies that participated in the VersionOne Agile Report started scaling with Scaled Agile Framework (SAFe) [2]

3

Agile development relays on self organizing teams with intra- and inter-team communication



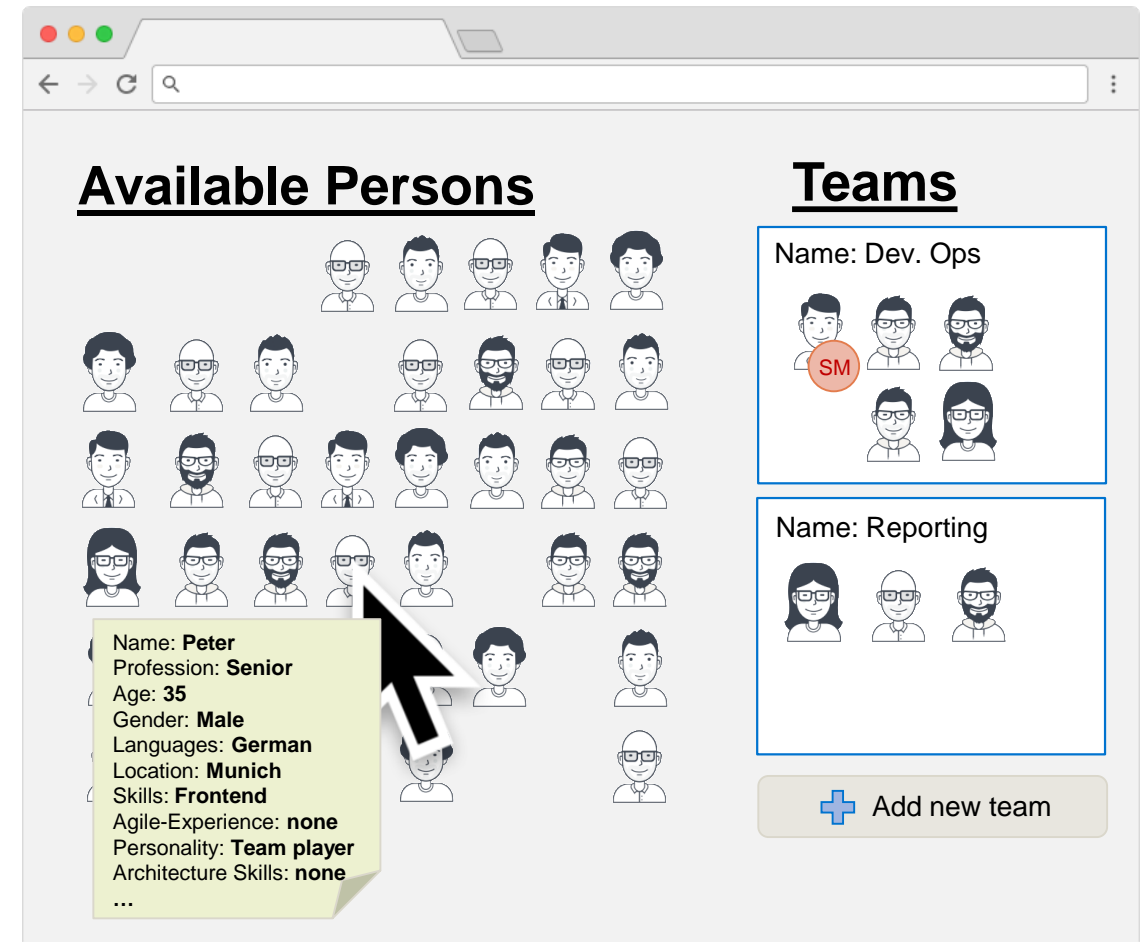
Sources:
[1] Google Trends: 06.12.2018
[2] VersionOne 12th Annual State of Agile Report

Problem: Optimization of the Available Resources

- Many frameworks (e.g. Scaled Agile Framework (SAFe), Large Scaled Scrum (LeSS), Disciplined Agile Delivery (DAD)) try to define methods, activities, principles and artefacts to optimize and define the processes
- In the end the teams are responsible for the result and the frameworks can only define rules

Question: How to get the best out of the available resources you have?

- With the following conditions:
 - Framework is set
 - Resources are set
 - Goals and tasks are set



01
RQ

Research Question 1

What positive and negative influence factors exist on team and program level in literature and which can be mapped to an agile environment?

> Structured
Literature
Review

02
RQ

Research Question 2

Can the multi-team system (MTS) concept be applied to large-scale agile programs in order to adapt the existing research in this area?

> Structured
Literature
Review

03
RQ

Research Question 3

Can the teamwork quality (TWQ) model be applied by the case study partner on the team level and are there any additional significant factors that can be added?

> Quantitative
Survey +
Case Study

04
RQ

Research Question 4

Can the TWQ model be applied from the team level to the program level?

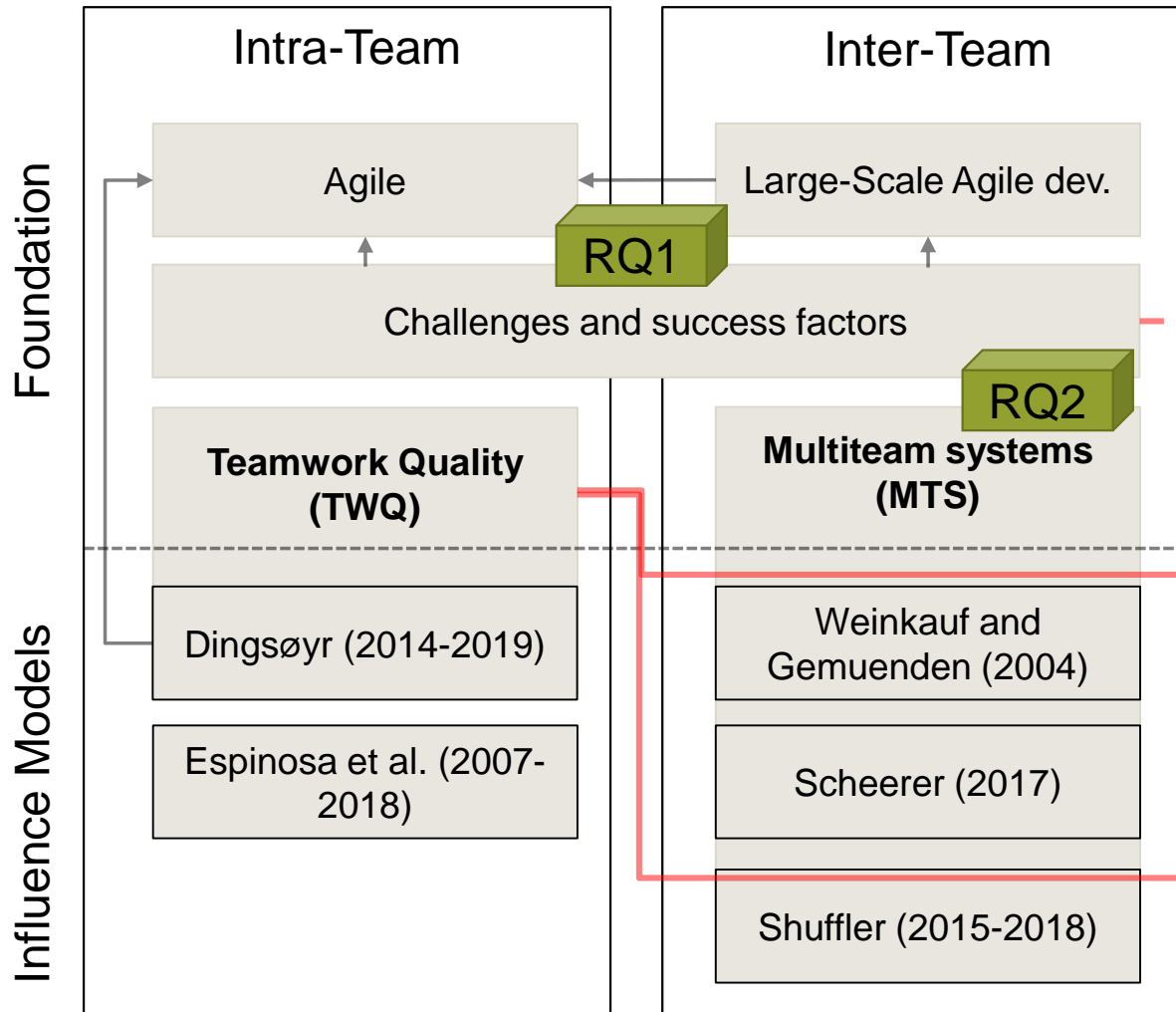
> Quantitative
Survey +
Case Study

Sources: Vom Brocke, Jan, et al. "Reconstructing the giant: On the importance of rigour in documenting the literature search process." *Ecis*. Vol. 9. 2009.

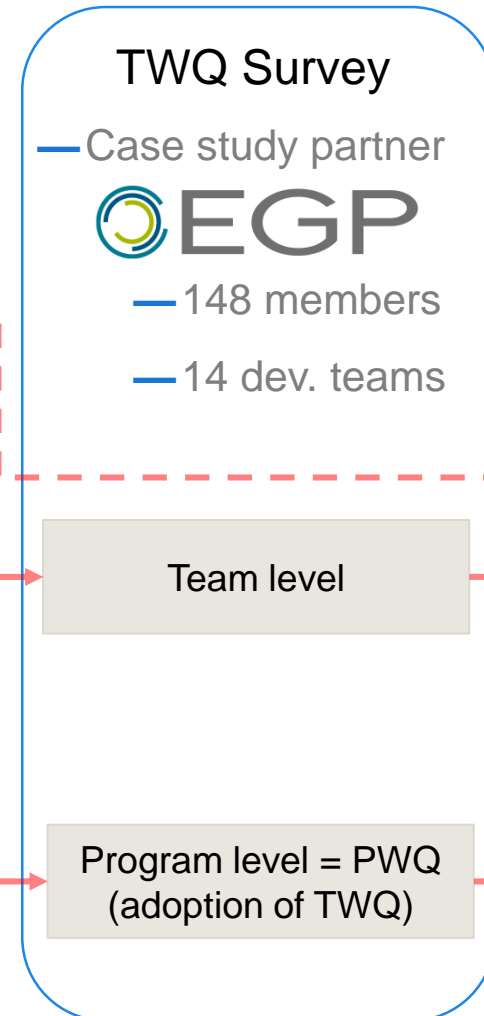
R. Yin, *Case Study Research: Design and Methods*. Beverly Hills, CA: Thousand Oaks, Sage Publications, 2013.

P. Runeson and M. Höst, "Guidelines for conducting and reporting case study research in software engineering", *Empir. Softw. Eng.*, vol. 14, no. 2, pp.131, 2008.

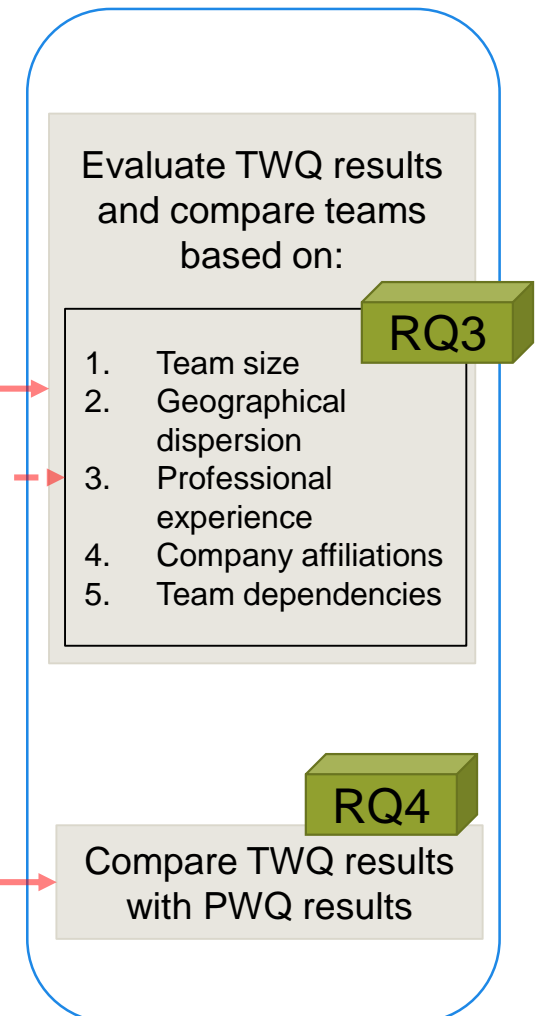
1. IDENTIFY INFLUENCE FACTORS / MODELS



2. CONDUCT SURVEY



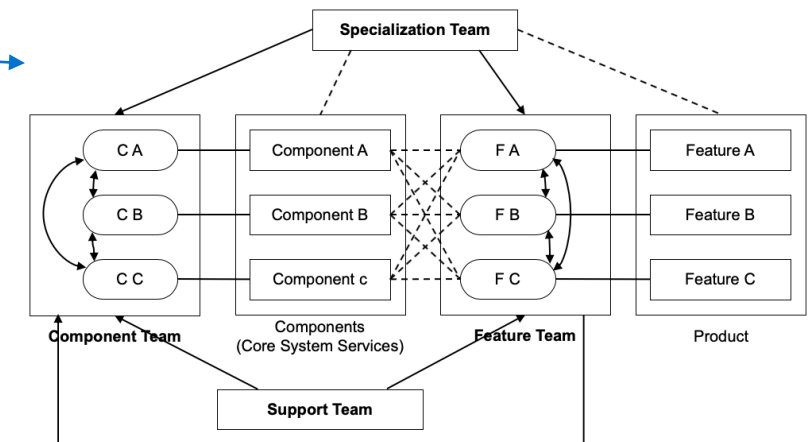
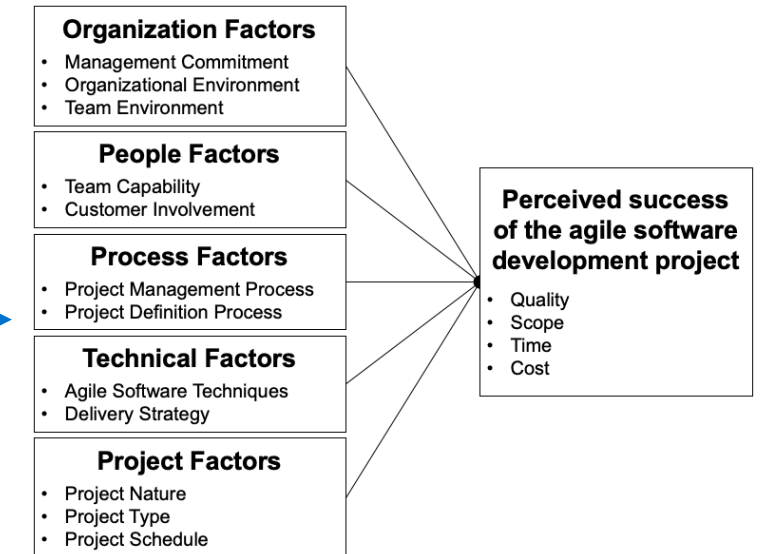
3. EVALUATE RESULTST



What positive and negative influence factors exist on team and program level in literature and which can be mapped to an agile environment?

Some examples of factors for an agile program:

- Cockburn (2001): Solid on-side setup
 - 2-8 experts in one room; a Increment of one month; fast release train
- Chow and Cao (2008)
 - Five clusters that have a direct impact on the success
- Cohen, Lindvall and Costa (2004)
 - Culture, people and communication are the key values of success
- Maurya (2018)
 - Split the teams with different focus
- Dikert, Kim and Paasivaara (2016) did a systematic literature review of fifty-two papers to find challenges and success factors for large-scale agile transformations



Sources: (1) A. Cockburn and J. Highsmith. "Agile software development, the people factor." In: *Computer* 34.11 (2001), pp. 131–133

(2) T. Chow and D.-B. Cao. "A survey study of critical success factors in agile software projects." In: *Journal of systems and software* 81.6 (2008), pp. 961–971.

(3) D. Cohen, M. Lindvall, and P. Costa. "An introduction to agile methods." In: *Advances in computers* 62.03 (2004), pp. 1–66.

(4) S. Maurya. *Categorise Your Agile Teams To Manage Dependencies and Avoid Overlapping Issues & Conflicts*. 2018 (accessed March 23, 2019).

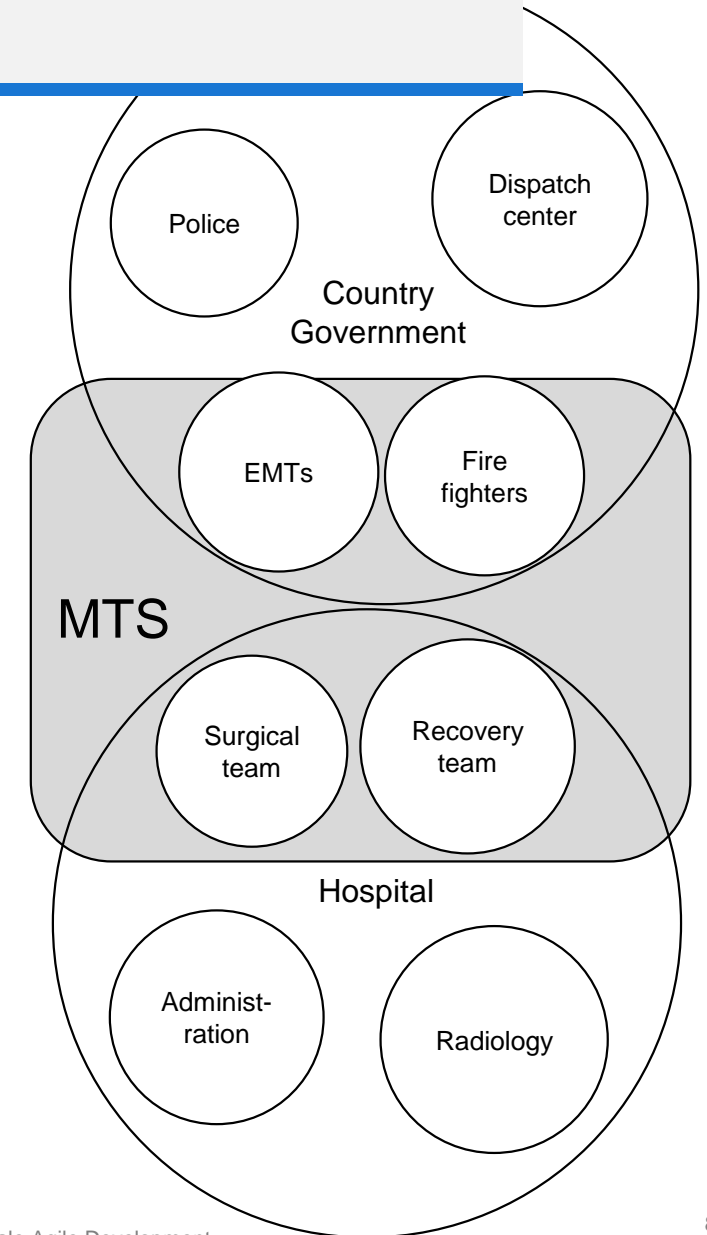
(5) K. Dikert, M. Paasivaara, and C. Lassenius. "Challenges and success factors for large-scale agile transformations: A systematic literature review." In: *Journal of Systems and Software* 119 (2016), pp. 87–108.





Can the multi-team system (MTS) concept be applied to large-scale agile programs in order to adapt the existing research in this area?

- Multiteam systems (MTS) are two or more **teams** that interface directly and **interdependently** in response to environmental contingencies toward the accomplishment of **collective goals**

MTS Characteristics:

1. Two or more teams that are unreducible, distinguishable complete with interdependent members and proximal goals (short-term goals)
2. Are unique entities that are larger than teams yet typically smaller than the larger organization
3. All component teams exhibit input, process, and outcome interdependence with at least one other team
4. Have a single superordinate goal, in which all component teams have a vested interest



 <h2 style="margin: 0;">MANAGING COORDINATION IN MULTITEAM SYSTEMS: INTEGRATING MICRO AND MACRO PERSPECTIVES</h2>	 <h2 style="margin: 0;">EXTENDING REPRESENTATIONAL GAPS THEORY TO ENHANCE PERFORMANCE IN MULTITEAM SYSTEMS</h2>	 <h2 style="margin: 0;">The Continued Evolution of Team Research: A Theoretical Model of Performance in Multiteam Systems</h2>	 <h2 style="margin: 0;">The Science of Multiteam Systems: A Review and Future Research Agenda</h2>
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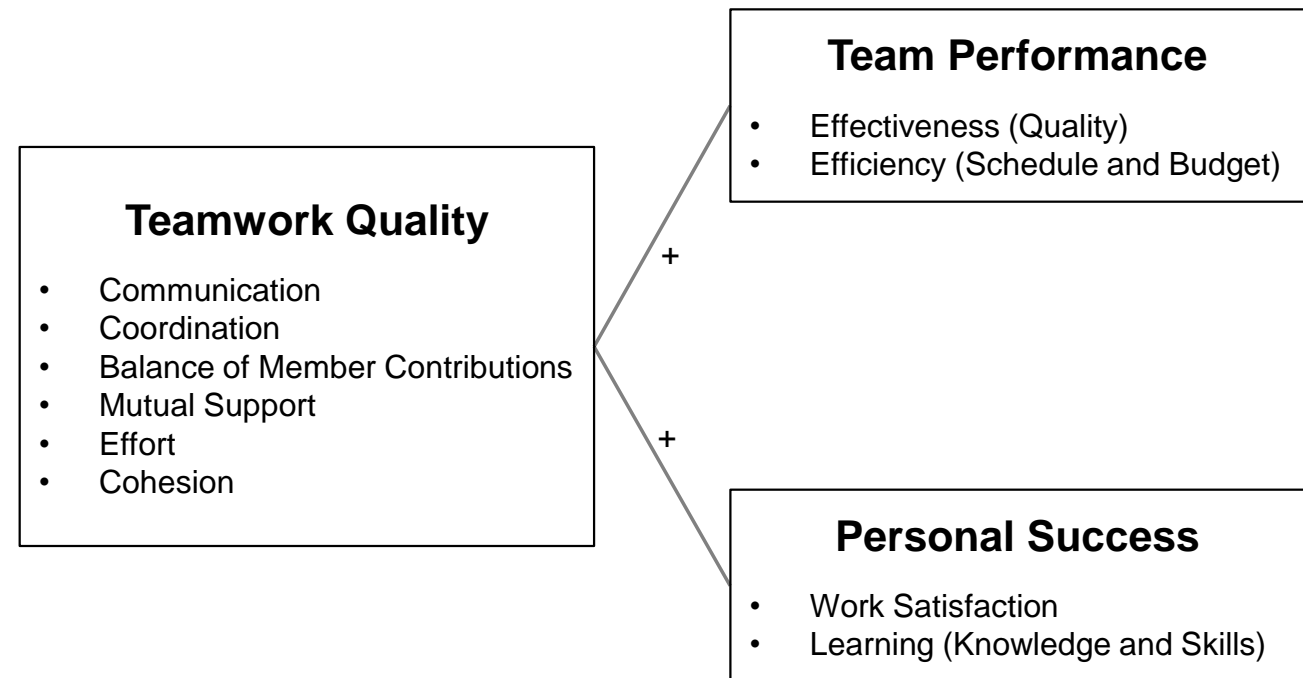
Year	2016	2015	2005	2015
Main topic	Horizontal and vertical coordination	Performance support to non-support (pointer) teams	Communication and leadership	Intra- and Inter-team attributes and connections
Qualitative or quantitative	Quantitative	Quantitative	Qualitative	Qualitative
Cited by	13	27	3	35
Software / Agile	No	No	No	No
Study type	Case study	Lab	Literature review	Literature review
Matches	No, coordination is in all teams the same	Partially; comparison of teams with many enablers to other teams	Yes	Yes

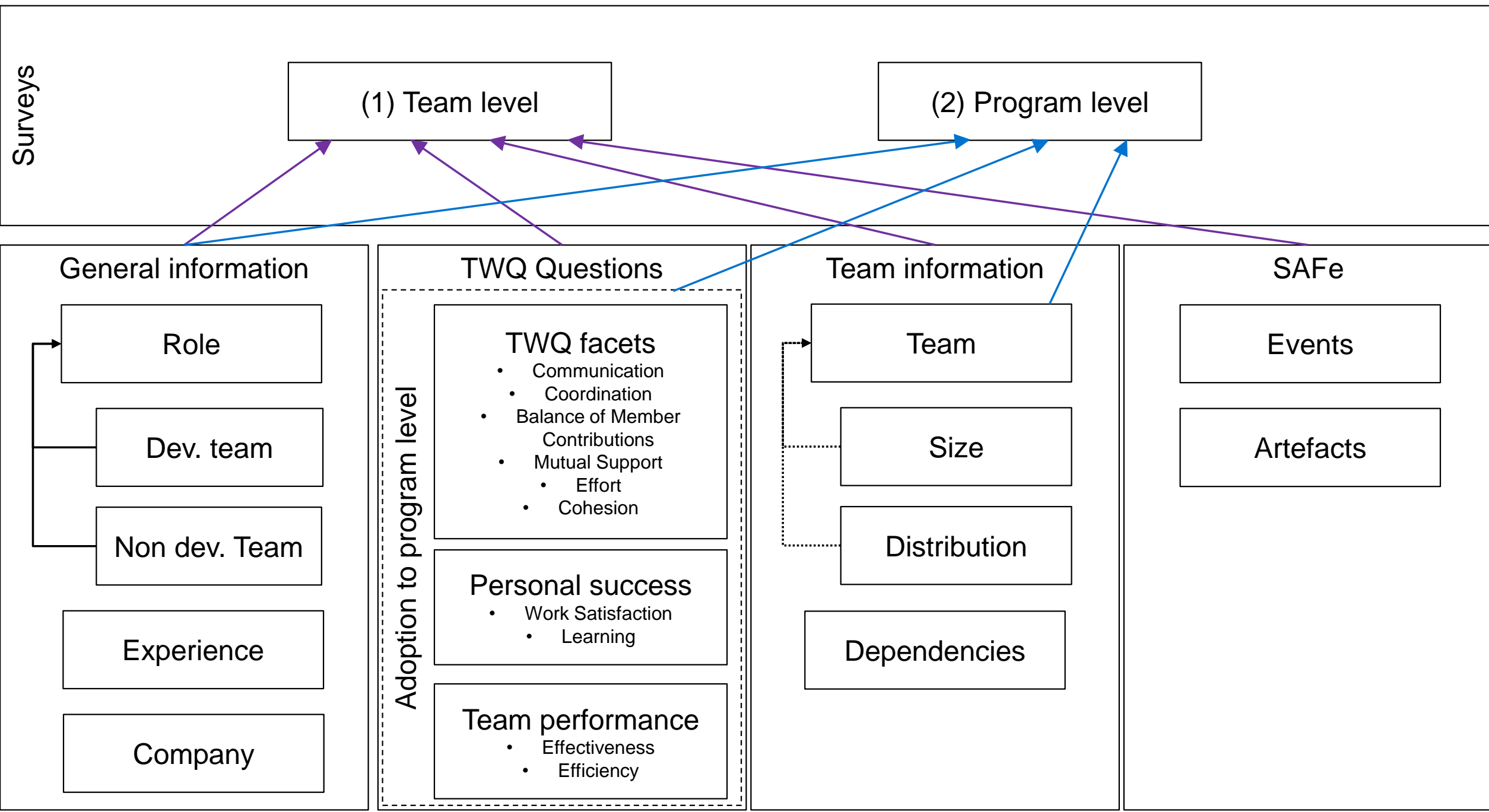
and More

Can the teamwork quality (TWQ) model be applied by the case study partner on the team level and are there any additional significant factors that can be added?

Survey

- Based on the 60 TWQ questions TWQ from Hoegl and Gemuenden (2001)
- Likert scaled (five-point answer scale); After one day the “Don’t know” was added, based on user feedback
- 79 participants on team level (57 Dev., 4 PO, 8 SM, 10 Stakeholder)





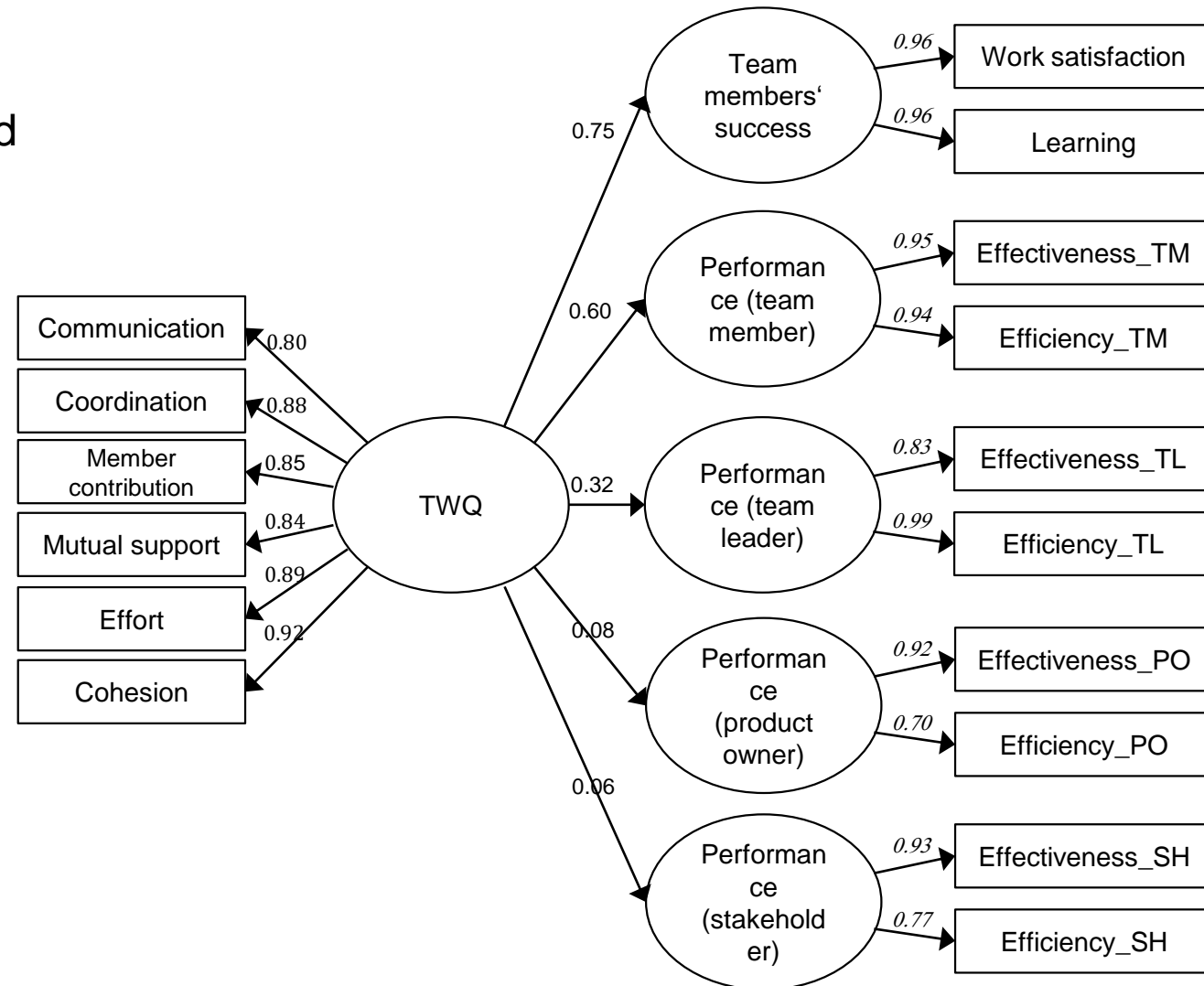
1. Structural Equation Models (SEM)

is a statistical model that allows the estimation and testing of correlative relationships between dependent variables and independent variables, and the hidden structures between them.

2. Multi-Group Analysis (MGA)

splits the data-set by grouping variable (such as size) and then the model is tested with each data-set

3. Test Model-Fit



... Indicator (item)

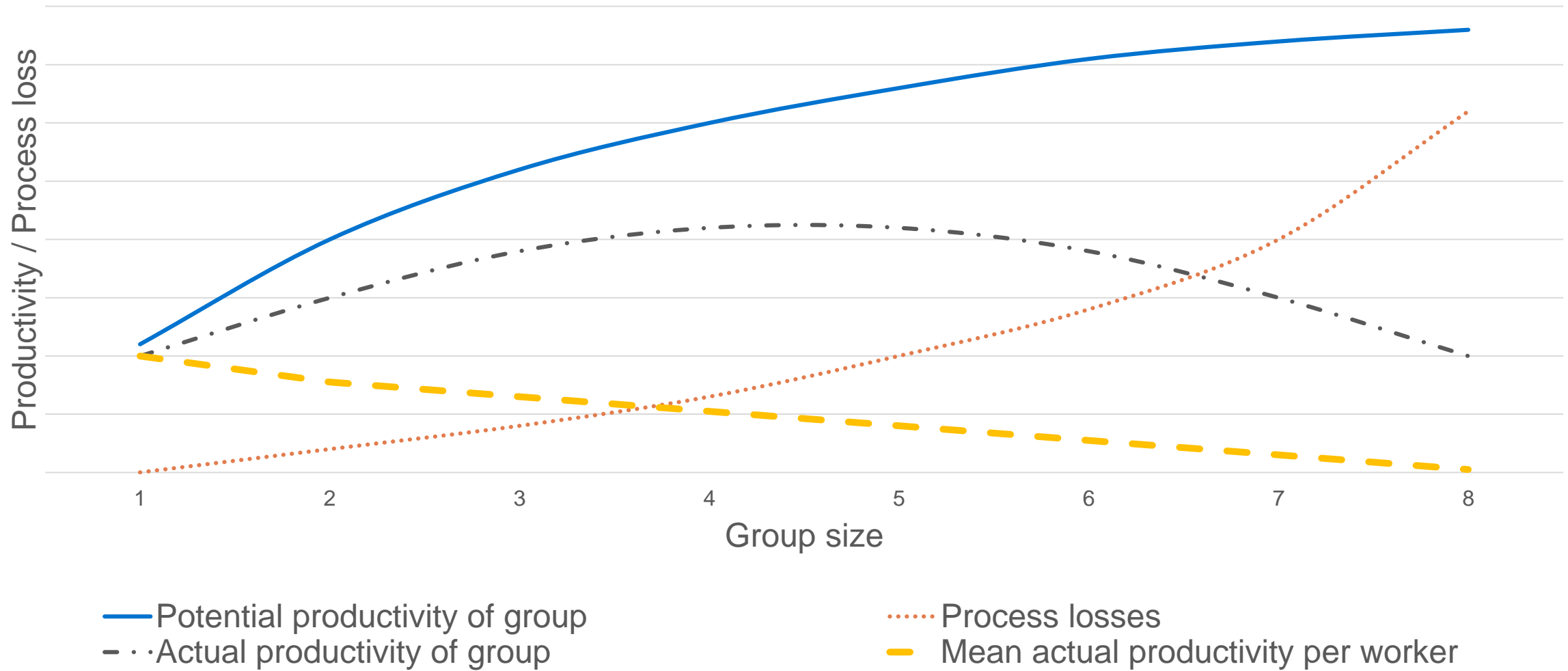
... Latent variable (factor)

Can the teamwork quality (TWQ) model be applied by the case study partner on the team level and are there any additional significant factors that can be added?

Hypotheses:

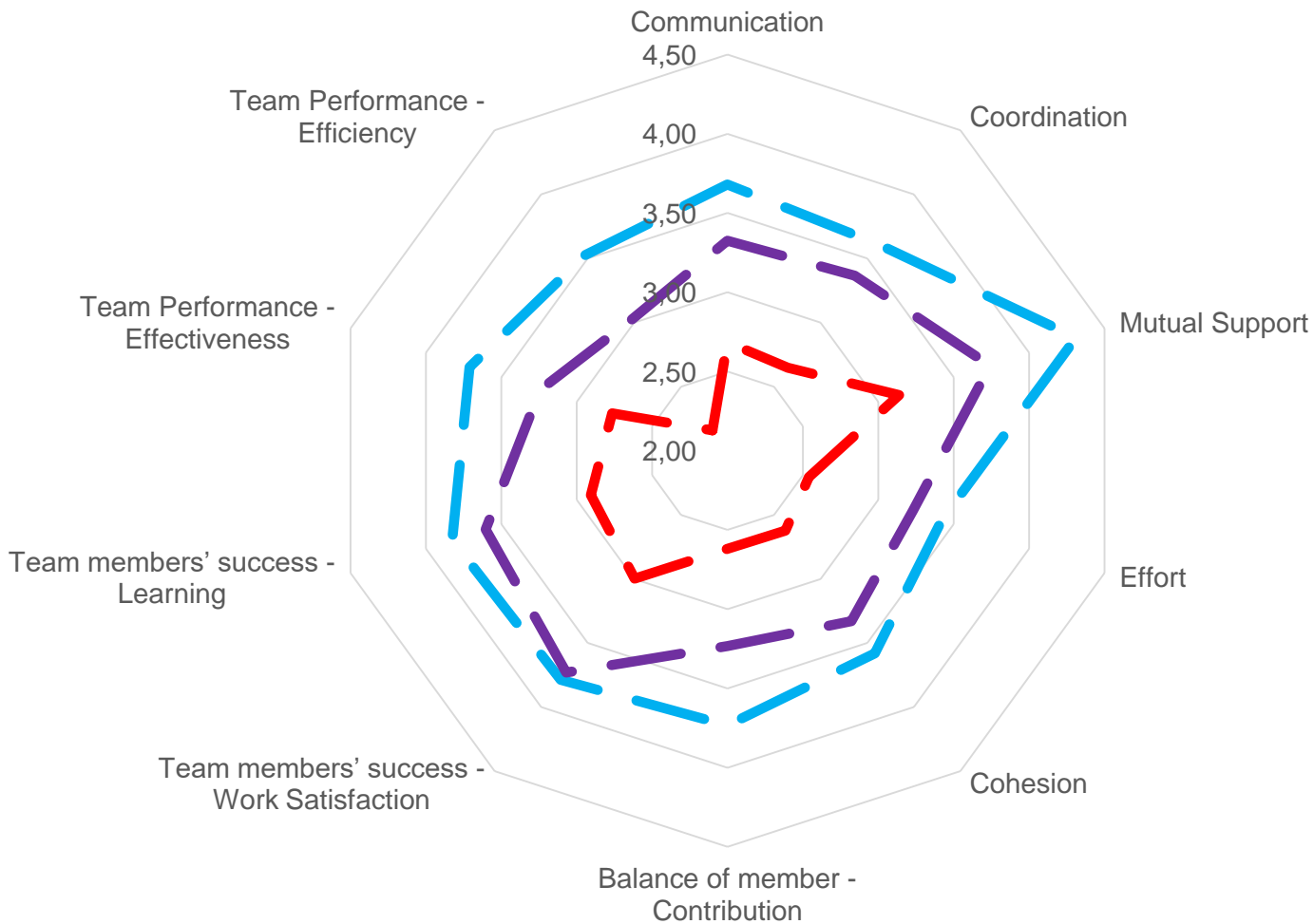
- H1** Team size has an impact on TWQ
- H2** Team distribution has an impact on TWQ
- H3** Professional experience of team members has an impact on TWQ
- H4** Different company affiliations of team members have an impact on TWQ
- H5** The number of dependencies to other teams in the program have an impact on TWQ

Team size impact on TWQ



Sources: I. D. Steiner. "Group process and productivity (social psychological monograph)." In: (2007).

Team size impact on TWQ



SEM Results:

	Overall	Small	Medium	Large
Communication	0,82	0,85	0,84	↓ 0,55
Coordination	0,89	0,91	0,96	↓ 0,70
Mutual support	0,84	0,87	0,82	0,81
Effort	0,87	0,76	↑ 0,99	0,90
Cohesion	0,92	0,95	0,93	0,89
Contribution	0,85	0,84	0,85	0,82
Success (TM)	0,79	0,88	↓ 0,66	0,71
Performance (TM)	0,62	0,67	↓ 0,20	0,71

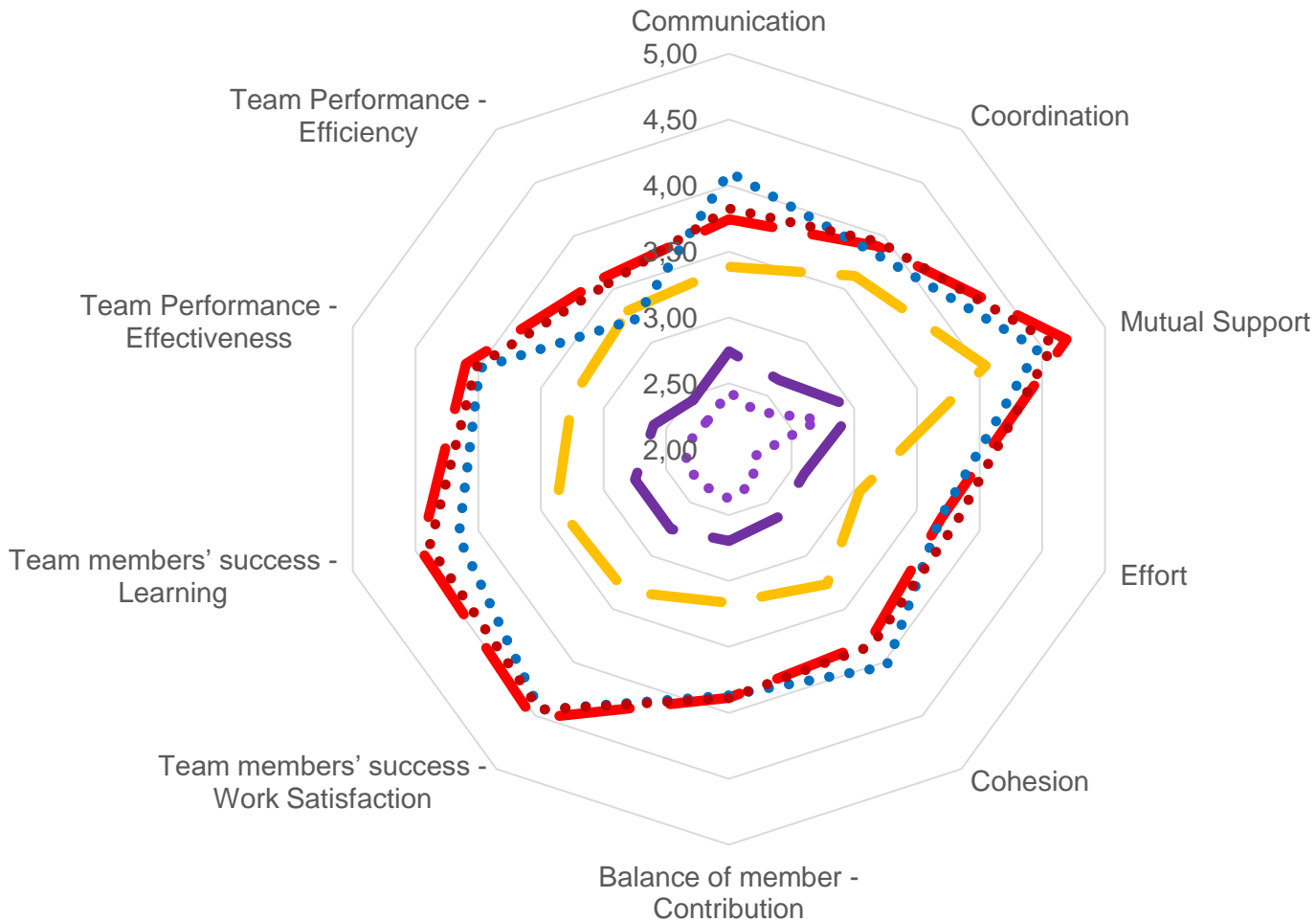
Cluster	Condition	Survey data sets	Teams	Team Member
█ Small	<= 7	27	5	33
█ Medium	<= 9	19	5	41
█ Large	> 9	28	4	63

Team dispersion impact on TWQ



Team	Team size	Locations	Factor
GPL	2	2	50%
RTE	2	2	50%
SPO	5	4	28%
SA	2	2	50%
ACC	7	2	76%
ANA	6	3	60%
CRA	7,5	2	61%
CRE	28	5	57%
CRP	9	4	38%
FRM	8	1	100%
FWK	7	4	30%
MDA	15	8	16%
MET	8,5	4	29%
PST	10	1	100%
REP	8	3	38%
SR	6	3	50%
SYS	10	3	49%
UIF	7	5	27%
SUM / AVG.	148	3,2	50%

Team dispersion impact on TWQ



Mean results of the team survey on team level grouped by the distribution.

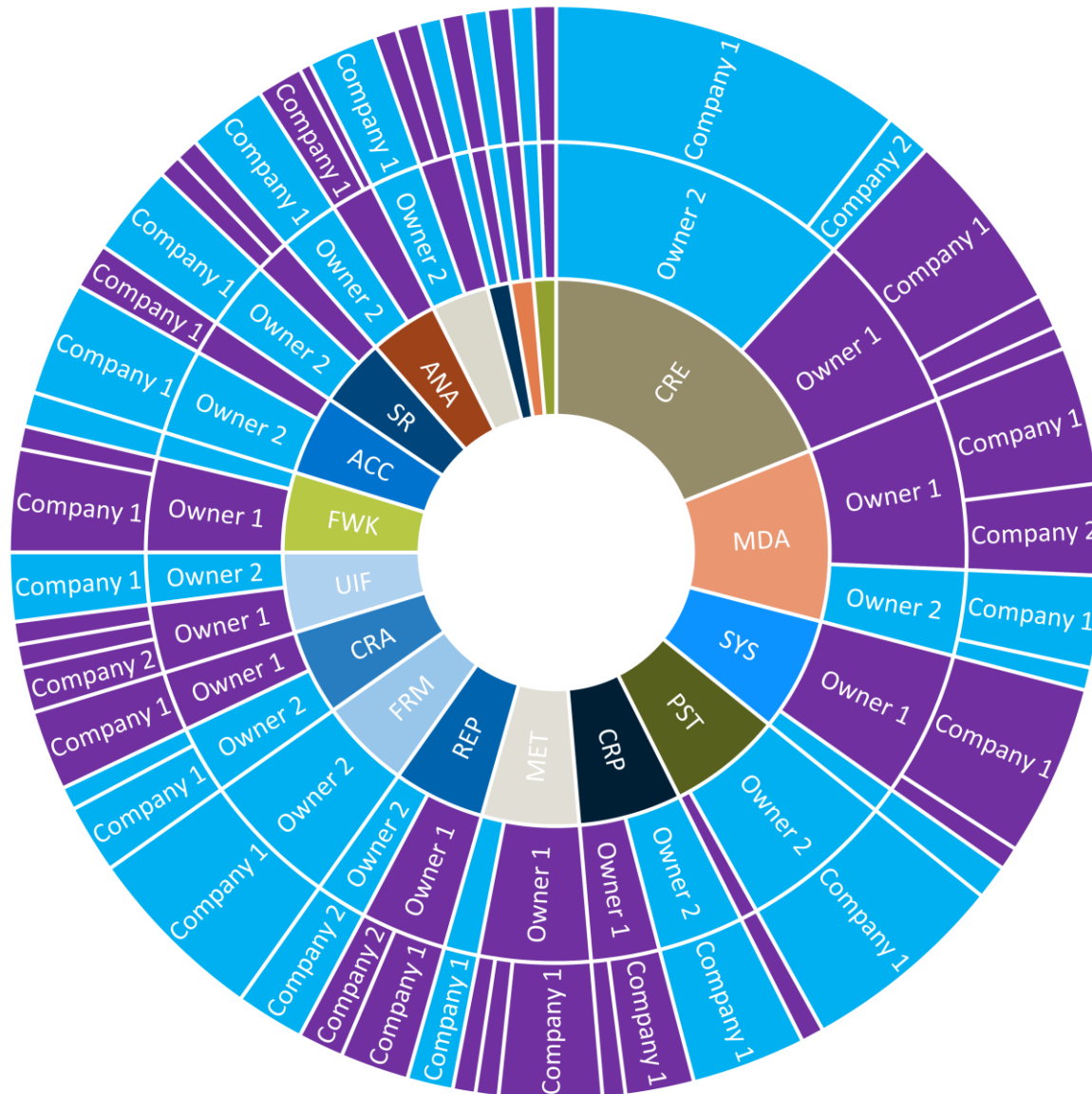
SEM Results:

Communication
 Coordination
 Mutual support
 Effort
 Cohesion
 Contribution
 Success (TM)
 Performance (TM)

	Overall	>2/3	Some	Many
Communication	0,82	0,88	0,87	0,81
Coordination	0,89	0,90	0,93	0,82
Mutual support	0,84	0,84	0,84	0,83
Effort	0,87	0,94	0,80	0,90
Cohesion	0,92	0,96	0,95	0,92
Contribution	0,85	↑ 0,96	0,84	0,84
Success (TM)	0,79	0,82	↑ 0,90	0,73
Performance (TM)	0,62	↑ 0,76	↓ 0,50	↑ 0,77

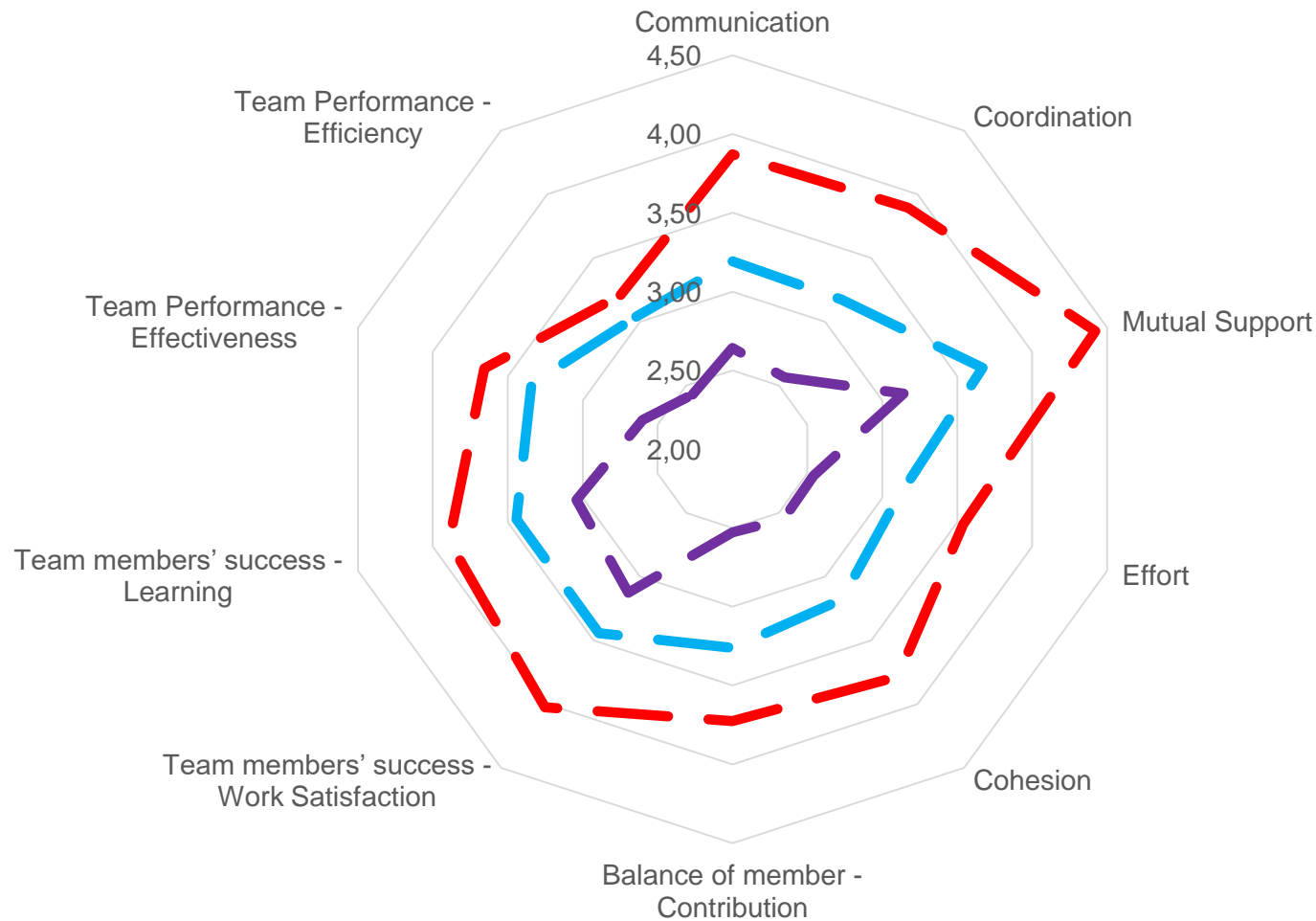
	Cluster10	Condition	Survey data sets	Teams	Team Member
—	One	1 Loc.	11	2	18
—	Some	<= 3 Loc.	25	6	44,5
—	Many	> 3	38	6	74,5
••••	Dis.<= 1/3	<= 1/3	21	4	37,5
••••	Dis.<=2/3	<=2/3	35	7	74,5
••••	Dis.<3/3	<3/3	7	1	7

Company affiliations impact on TWQ



Team	Team size	Company (Factor)
GPL	2	50%
RTE	2	50%
SPO	5	52%
SA	2	50%
ACC	7	59%
ANA	6	51%
CRA	7,5	50%
CRE	28	53%
CRP	9	51%
FRM	8	100%
FWK	7	66%
MDA	15	56%
MET	8,5	64%
PST	10	82%
REP	8	53%
SR	6	56%
SYS	10	75%
UIF	7	51%
SUM / AVG.	148	59%

Company affiliations impact on TWQ



Mean results of the team survey on team level grouped by the companies the people come from.

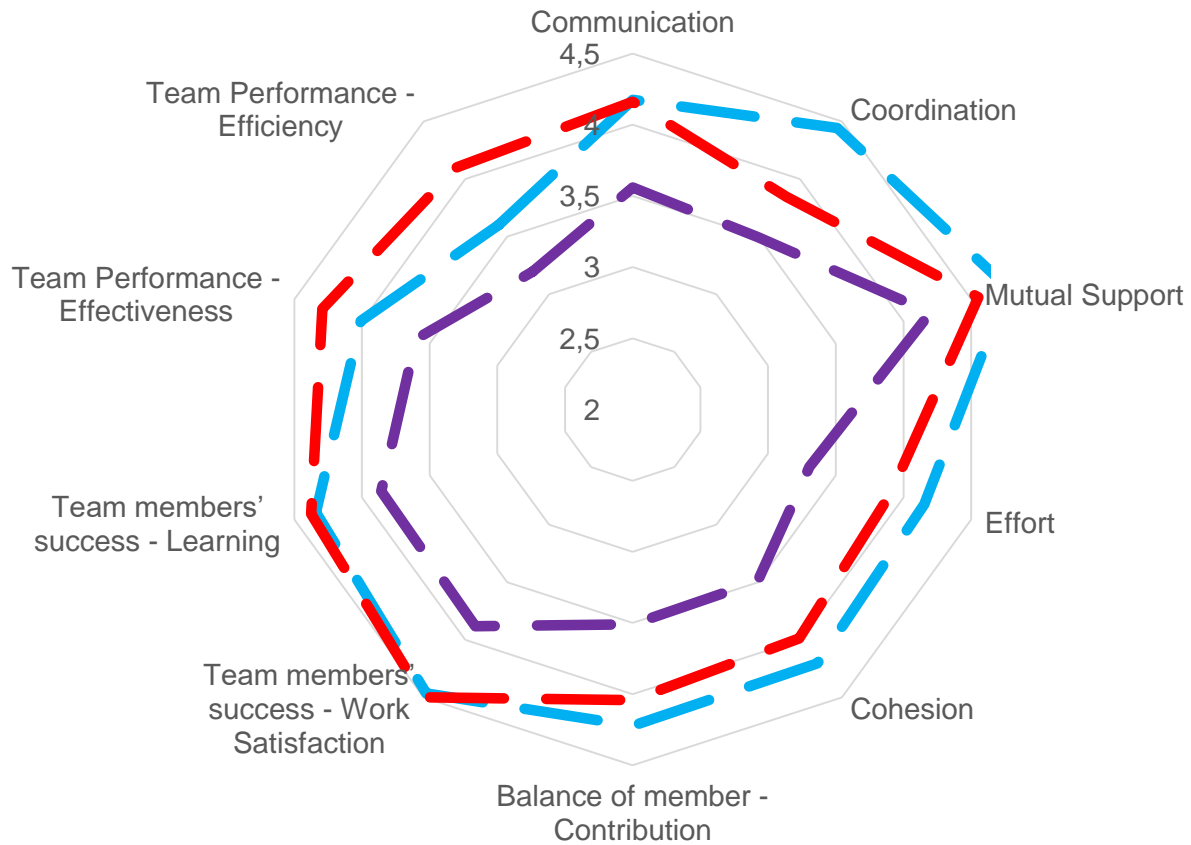
SEM Results:

Communication
 Coordination
 Mutual support
 Effort
 Cohesion
 Contribution
 Success (TM)
 Performance (TM)

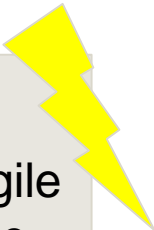
	Overall	Owner 1	Half/Half	Owner 2
Communication	0,82	0,77	0,82	0,87
Coordination	0,89	0,92	0,90	0,91
Mutual support	0,84	↓ 0,59	0,87	0,81
Effort	0,87	0,88	0,87	0,94
Cohesion	0,92	0,99	0,92	0,95
Contribution	0,85	0,82	0,84	0,95
Success (TM)	0,79	↓ 0,47	0,82	0,78
Performance (TM)	0,62	0,63	0,66	0,62

Cluster	Condition	Survey data sets	Teams	Team Member
Half/Half	< 2/3 of one Owner	42	7	80,5
Owner 1	Min 2/3 Owner 1	9	3	25,5
Owner 2	Min 2/3 Owner 2	23	4	31



Agile experience impact on TWQ



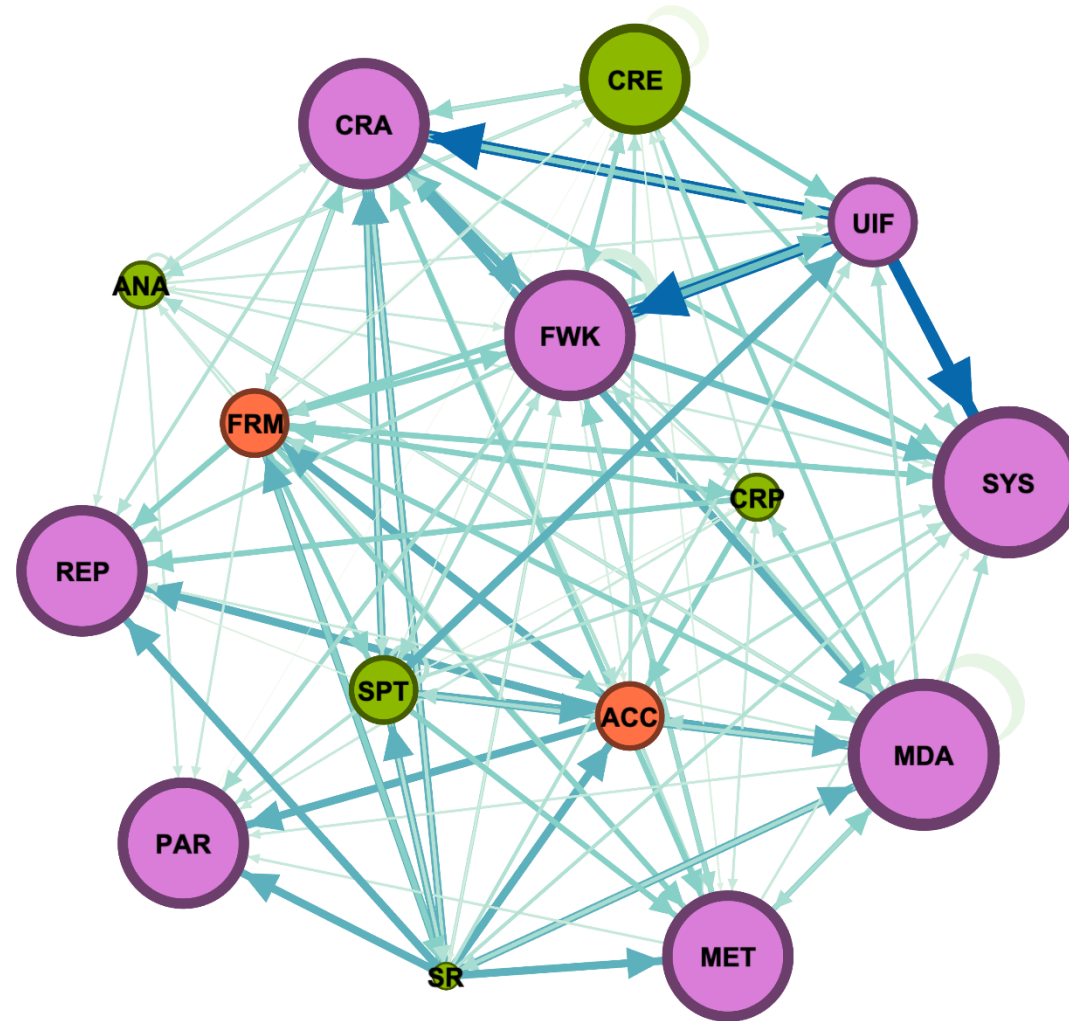
Team with ≤ 2 and > 4 years of agile experience are all teams with the team size: small.



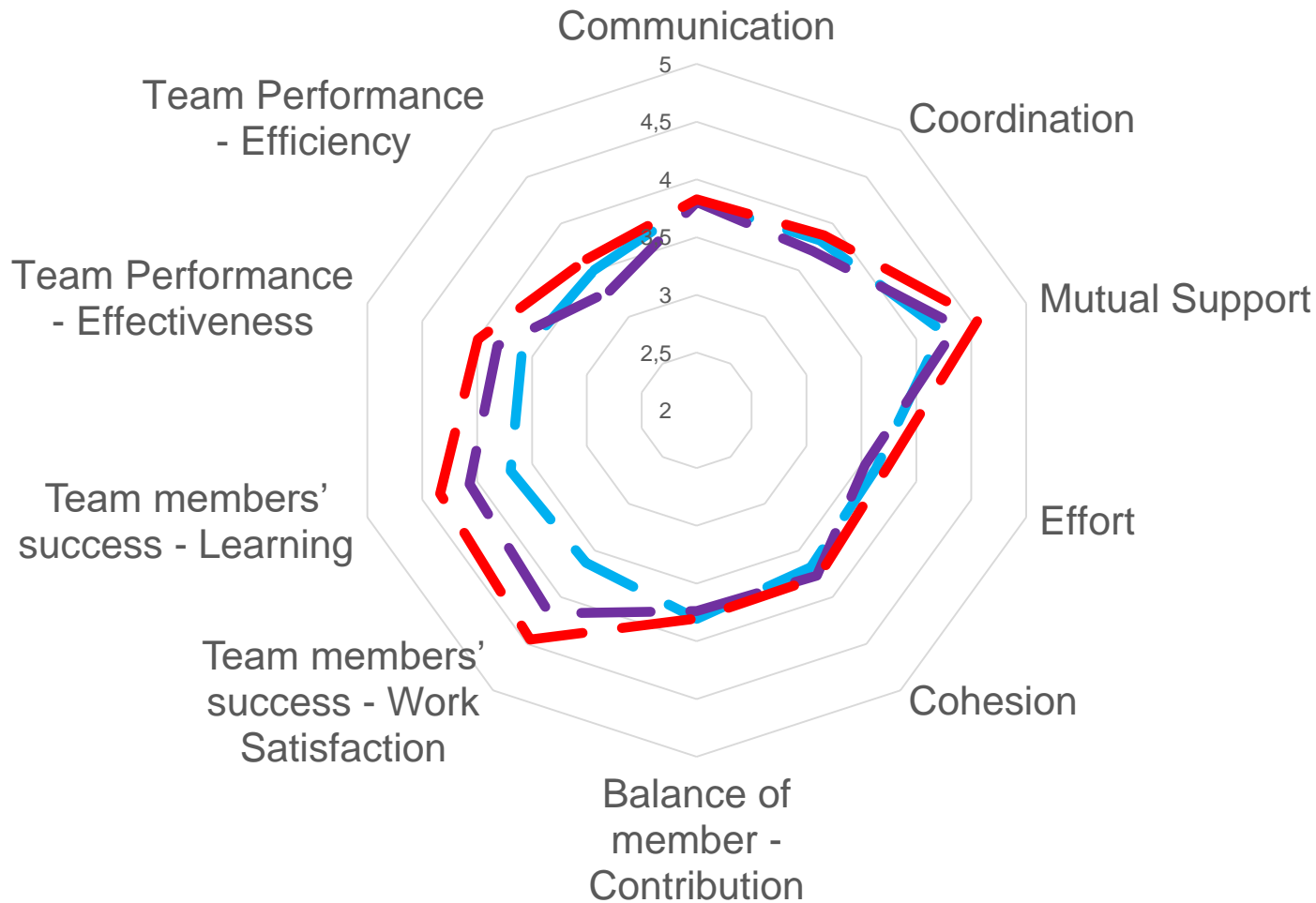
Mean results of the team survey on team level grouped by the agile experience if the the team member average.

Cluster	Condition	Survey data sets	Teams	Team Member
	inexperienced Avg. ≤ 2 years	13	3	23
	middle Avg. ≤ 4 years	50	7	81,5
	experienced Avg. > 4 years	11	2	14,5

Number of dependencies to other teams impact on TWQ



Number of dependencies to other teams impact on TWQ



SEM Results:

	Overall	<=8	>8 and <=11	>11
Communication	0,82	↑ 0,98	0,81	0,79
Coordination	0,89	↑ 0,99	↓ 0,76	0,82
Mutual support	0,84	0,95	0,82	0,74
Effort	0,87	0,98	0,74	0,94
Cohesion	0,92	0,98	0,90	0,95
Contribution	0,85	0,93	0,87	0,83
Success (TM)	0,79	↑ 0,97	0,75	0,68
Performance (TM)	0,62	↑ 0,77	0,65	↓ 0,28

Cluster	Condition	Survey data sets	Teams	Team Member
— inexperienced	<= 8 dependencies	16	3	21
— middle	>8 and <= 11 dep.	34	5	60
— experienced	>11 dependencies	24	6	56

	Hoegl and Gemuenden	Lindsjörn et al.	TWQ	PWQ
Communication	0,88	0,84	0,82	0,84
Coordination	0,71	0,47	0,89	0,76
Mutual Support	0,89	0,87	0,84	0,80
Effort	0,82	0,74	0,87	0,91
Cohesion	0,89	0,90	0,92	0,87
Contribution	0,89	0,73	0,85	0,82

Team member

Success	0,93	1,00	0,79	0,79
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Team member

Performance	0,64	0,68	0,62	0,80
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Team leader

Performance	0,34	0,32	0,22	0,28
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PO

Performance	0,26	0,06	0,15	0,05
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Stakeholder

Performance	-	-	0,10	0,10
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Not strong leadership. Self-organizing teams. The team makes decisions; estimates, prioritizes, and delegates tasks in particular. (3)

Work satisfaction and learnings have still a high loading, but are not so relevant for this program

The overall program performance is a very visible result and is often communicated from the management

- Lack of detailed information about relevant performance measures (2)
- PO rate more external factors, like the amount of communication the group has with external agents (1)

Sources: (1) Cohen, S., Bailey, D., 1997. What makes team work: group effectiveness. Research from the shop floor to the executive suite. J. Manage. 23 (3), 239–290. doi: 10.1177/014920639702300303

(2) Hoegl, M., Gemuenden, H.G., 2001. Teamwork quality and the success of innovative projects: a theoretical concept and empirical evidence. Organ. Sci. 12 (4), 435–449. doi: 10.1287/orsc.12.4.435.10635

(3) Y. Lindsjörn, D. I. Sjøberg, T. Dingsøy, G. R. Bergersen, and T. Dybå. "Teamwork quality and project success in software development: A survey of agile development teams." In: Journal of Systems and Software 122 (2016), pp. 274–286.



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