Paper title: Innovation problem solving in different Triple Helix contexts

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Triple Helix 2002
Track 12. Structural Preliminaries of Innovations and their interdependence with the cultural context.

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# Innovation problem solving in different Triple Helix contexts

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**Abstract:**

Europe is said to have a special approach concerning the antecedences of innovation. This approach has heavily relied upon self-organizing international networks for the last 30 years. Although these networks have been studied and evaluated from different research traditions, the specific ways in which these communities address innovation problems and innovation issues has not yet been studied sufficiently. The paper investigates how self-organizing international research networks tackle their research agenda and innovation problems. This question is addressed by means of bivariate correlation of culture and context descriptors with five dimensions of innovation success. These relationships are first-level candidates for future investigations of moderating and mediating effects. The study allows to explore the effect of university researcher domination / low industry involvement and fuller sets of Triple Helix integration. Data is derived from a sample of 160 professional researchers who actively participated in more than 100 different European research networks (C.O.S.T.). The quantitative part of the study is derived from a survey in February 2002 with 160 completed self-administered questionnaires. The availability of 'thick-descriptions' from preparatory studies (totalling more than 130 two hour interviews) allows reflecting the study outcome upon trends towards commercialisation of science, research and innovation management as well as science and technology policy issues.

## 1. Introduction

Networks are said to be Europe's special approach concerning the antecedences of innovation. Relationships in networks typically differ from those in close cooperation settings or in mere transactions. Does the composition of different cultures influence the innovation success? How is the success of innovation-related problem solving activities influenced by networks where universities dominate, are among themselves or integrate industry and / or governments?

Within this paper we introduce shortly what we understand by innovation-related problem solving, by culture, then introduce the network C.O.S.T. where our data is gathered from and present results of bivariate correlations between cultural and context descriptors and five dimensions of perceived innovation success. We then discuss implications for further research and for 'managing' innovation. All bivariate correlations for all Triple Helix-related subgroups are presented in Table 1 together with the full questionnaire in the annexe.

### 1.1 Setting the Scene

Science leads European integration. During the last thirty years more than 40000 European researchers have participated in more than 1000 research networks under the Programme C.O.S.T. (Cooperative Science and Technology). Currently more than 200 networks are operational. COST had often been framed as instrument to reduce supposed north-south and west-east differences and to help non-EU member states with their integration work.

The underlying rationale for innovation in C.O.S.T. is twofold. First it is to a very high degree bottom-up. Programming is done on a research proposal basis as long as half a dozen member countries decide to participate and nominate a researcher who actually works on a scientific project on this issue. Second C.O.S.T. strives for leveraging existing research and innovation by spending less than one per cent of the underlying (local) research expenditure (mostly travel expenses to regular network gatherings, staff exchange and administrative support). A new C.O.S.T. network typically did not exist before and is co-funded for a time period of 4 to 6 years. Although originally designed for scientific networks an increasing number of leading-edge scientists attract participants form both industry and public authorities to participate in C.O.S.T. This is done for a variety of reasons – mostly related to a more valid problem conception of highly complex issues. Although the (future) participants of a specific C.O.S.T. - network are not known a researcher has almost no way of leaving the network once he is nominated as national delegate. This leads to the – here interesting – effect that researchers might have entered a purely academic culture and ended up in a full Triple Helix setting where governmental experts and industry are also present (yet these always make a very small share).

Typically evaluation studies underestimate the contribution of this type of networks for innovation (cf. Foray (2002), BIDAULT / FISCHER 1994). Networks in their true practice and nature are difficult to grasp[1]. Although these networks have been studied and evaluated from different research traditions, the specific ways in which these communities address innovation problems and innovation issues have not yet been studied sufficiently (BOTKIN 1999, DeBRESSON / AMESSE / CASTI 1995, FREEMAN 1991, GRANOVETTER 1982, KLEINALTENKAMP / SCHUBERT 1994, Sonderforschungsbereich Vernetzung als Wettbewerbsfaktor: www.vernetzung.de/).

The idea of exploiting networks as the European strength has become even more prominent in ongoing preparation work for the European research Area and the 6th Framework Programme of the European

[1] Cf. Cross / Nohria / Parker (2002), BÚRCA S. de, MCLOUGHLIN D.: "Businesss Network Research: A Grounded Theory Approach". In: NAUDÉ P., TURNBULL P. W.: "Network Dynamics in International Marketing". Pergamon, Oxford, 1998.

Commission. However C.O.S.T. has had major difficulties recently due to rather strong tendencies towards top down or industry led research programming (see BIT, BM:VIT, BUNDESAMT FÜR BILDUNG UND WISSENSCHAFT, DREBORG, NISSINEN / NISKANEN, PREST).

We were commissioned a study where we could interview all Austrian Scientists who participated in C.O.S.T. at that time (Cf. Aigner / Hasenauer / Kurz / Leitgeb / Meinhard 2000). Given the limited validity of existing concepts on networks we had decided to follow a purely bottom-up qualitative research design. What we had found hardly is captured in intuitive network metaphors or academic evaluation reports on this subject. This is important because networks are an effective form of structural preliminaries of innovation (Foray (2002), Alter (2002), Bach / Lhuillery (1999), Foray / Mairesse (1999)) yet are often discussed in terms of projects or pre-project / post-project activities. For the difficulties to grasp network realities we refer to McLoughlin / Horan (2000). In a second study we collected data via self-administered questionnaires from 160 professional researchers who actively participated in more than 100 different C.O.S.T. networks.

### 1.2 The problem reframed in terms of this Triple Helix session

Our paper contributes to our session's collective search on how Triple Helix-related differences in context and culture effect innovative problem solving in supra-national bottom-up-type research undertakings in Europe (cf. Ernø-Kjølhede, 2001) – esp. ones where you cannot or hardly can prevent other people from participating.

Therefore we had a quasi-experimental situation, where the individual respondent could not control in which cultural subgroup he participates. However on a work-group level some self-selection mechanism will probably have taken place and reduce the validity of our Triple Helix descriptors.

### 1.3 Methodology and Status of the research underlying this paper

We here use a data set that was not generated for investigation of the research question we are addressing here. The purpose of the original study was to investigate different stochastic models of team problem solving behaviour in academic research networks (cf. Meinhard, 2002). Only later we had access to the actual participant structure of those research networks. This was when we decided to explore Triple Helix related effects.

Therefore the character of the study is of exploratory nature and work in progress.

Most bivariate correlations between cultural subgroups and innovation success dimensions prove to be statistically highly significant and of medium to high strength. Yet if you take into consideration different sub-sample sizes and compare the prima

vista huge differences – what most often is not done – most of these differences are not significant statistically. (As this analysis for significant differences in correlation coefficients is not standard in SPSS we 'manually' calculated the significances according to Bortz[2].)

$$z = \frac{Z_1 - Z_2}{\sigma_{(Z_1 - Z_2)}} \text{ where } \sigma_{(Z_1 - Z_2)} = \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}$$

Due to statistical and procedural limitations our core assumption of a culture clash 'on the way from heaven via hell to paradise lost' remains speculative.

We take this as a starting point for outlining future research needs. Why we nevertheless 'like' this result. Two extensive qualitative field surveys in 2000 and 2001 (totalling more than 130 two hour interviews) helped prepare both the relevant perception space of the participating communities, develop the measurement dimensions as well as the final questionnaire.

The availability of these 'thick-descriptions' from the preparatory studies allows reflecting the study outcome upon trends towards commercialisation of science, research and innovation management as well as science and technology policy issues.

For the purpose of this paper we did not investigate the originally underlying multivatiate model but focussed on bivarate cultural influences upon innovation success dimensions.

## 2. The Concepts of innovation problem solving, Culture and (Research) Networks

Among the manifold of concepts we at least try to clarify three here by relating to research traditions and literature. We do not clarify Triple Helix again and this is not meant to be a literature review of related issues (see Meinhard, 2000 for an extensive literature review).

### 2.1 What is innovation problem solving?

Problem statements - tools for bridging gaps. Problem solving is a term widely used in our daily lives as well as in numerous scientific disciplines in pretty different ways. In order to provide a common terminological basis valid throughout the whole paper, here a problem is understood in the sense of cognitive sciences. Thus, according to Mayer[3], a problem is a situation representing a gap between an initial and a desired goal-state with the need to bridge this gap in some way. Following Robertson[4], the transfer of the initial state into the goal state is not possible in a direct manner, therefore requiring a focused sequence of cognitive processes performed by the problem-solving system.

The traditions of problem solving research we here relate to are based on experiences

[2] BORTZ J.: "Statistik für Sozialwissenschaftler", Vierte Auflage, Springer Berlin Heidelberg, 1993, S. 203

[3] Cf. MAYER R. E.: "Thinking, Problem Solving, Cognition", W.H. Freeman & Co, New York, 1983

4 Cf. ROBERTSON S. I.: „Problem Solving", Psychology Press Ltd, 2001

gained by Gestalt psychologists Duncker[5] and Wertheimer[6], the Information Processing Theory of Cognition introduced by Newell et. al.[7] and Newell and Simon[8], the investigations of Cognitive Sciences (e.g. Johnson-Laird and Wason[9] as well as Stillings et.al.[10]); then recent approaches addressing joint problem-solving processes[11] and finally the solution of complex, real world problems by teams (cf. Stempfle / Badkeschaub (2002)). In our original study we extended and merged different research traditions in order to analyse innovation problem solving behaviour in network settings. This knowledge is maintained in the measurement constructs for innovation success.

5 Cf. DUNCKER K.: "On Problem Solving", Psychological Monographs, 58, 1945, Whole #270
6 Cf. WERTHEIMER M.: "Productive Thinking", Harper & Row, New York, 1959
7 Cf. NEWELL A., SHAW J. C., SIMON A.: "Elements of a Theory of Human Problem Thought" in FEIGENBAUM E. A., FELDMAN J.: "Computers and Thought", McGraw Hill, New York, 1963, p. 279-293
8 Cf. NEWELL A., SIMON H. A.: "Human Problem Solving", Prentice-Hall, Inc., Englewood Cliffs, New Jersy, 1972
9 Cf. JOHNSON-LAIRD P. N., WASON P. C.: "Thinking: Readings in Cognitive Science", Cambridge University Press, Cambridge, 1977
10 Cf. STILLINGS N. A., FEINSTEIN M. H., GARFIELD E. L., RISSLAND D. A., ROSENBAUM S. E., WEISLER S. E., BAKER-WARD L.: „Cognitive Science", MIT Press, Cambridge, MA, 1987
11 Cf. BRYANT J.: "Problem Management – A guide for producers and players", John Wiley & Sons Ltd, Chichester, 1989; BROWN S., DUGUID P.: "The Social Life of Information", Harvard Business School Press, Boston, 2000; GIBBONS M., LIMOGES C., NOWOTNY H., SCHWARTHMAN S., SCOTT P., TROW M.: "The new production of knowledge – The dynamics of science and research in contemporary societies", Sage Publications, London, 1997; KOSCHATZKY K., BROSS U.: "Innovation Networking in a Transition Economy: Experiences from Slovenia" in KOSCHATZKY K., KULICKE M., ZENKER A.: "Innovation Networks", Technology, Innovation and Policy Series of the Fraunhofer Institute for Systems and Innovation Research, Physica-Verlag, Heidelberg, 2001; NONAKA I., KONNO N.: "The Concept of "Ba": Building a Foundation for Knowledge Creation", California Management Review, Vol. 40, No. 3, Spring 1998, p. 40-54; WENGER E.: „Communities of Practice: Learning, Meaning, and Identity", Cambridge University Press, 1998

## 2.2 Conceptions of culture

Culture mediates and moderates problem-solving behaviour (c.f. Hewett / Money / Sharma, 2002). This influence is different for close relationships as opposed to pure transactions and probably again for relationships in networks like C.O.S.T.

By culture we follow Deshpandé / Webster (1989) "the pattern of shared values and beliefs that help individuals understand organizational functioning and this provide them with norms for behavior in the organization." They suggest two dimensions generating four corporate culture types:

a. Internal maintenance versus external positioning dimension.
b. Organic versus mechanistic processes dimension.

1. Clans (internal organic)
2. Adhocracies (external organic)
3. Hierarchies (internal mechanistic)
4. Markets (external mechanistic).

The cultural context of our study can consequently be described as adhocracy-type although this framework does not fully capture our experience in researching these research networks.

However other culture related aspects of our paper have been mentioned implicitly already. These are:

- Specifically European
- Neither close relationships nor pure transactions
- University-dominated

- Midium-term (we only interviewed researchers at the end of a 4 to 6 year network life-cycle).
- Cross-cultural in terms of nationalities and language
- (locally) renowned researchers who can show a fully-financed scientific project

**2.3 Networks**

Networks are setting the scene for our empiric data yet they are not being investigated within this paper. Therefore we refer to the extensive body of literature on research networks (Goyal / Moragagonzalez (2002), Jacob / Hellström (2000), Wen / Kobayashi (2001); on networks in innovation contexts (Ruef (2002), Bonner / Baumann / (2002), Deroian (2002), Pyka (2000)) as well as network governance (Jones / Hesterly / Borgatti (1997), Harris / Coles / Dickson (2000), Kadushin (2002)).

**3. Results**

Results from table 1 show a statistically significant influence of culture and context upon innovation success. This is the case for most bivariate relationships in the entire sample as well as for several subgroups. The columns show the five dimensions of innovation success (technical success, time success, social success, scientific success, realisation success and economic success) together with the overall success indicator. The rows show most context and cultural descriptors (interdisciplinary team, industry participation, leadership quality, interest groups, personal engagement, work in small-teams, trust, informal contacts, fun, personnel exchange, problem statement, goal definition, personal contacts, competition, etc). For an easier orientation we have grouped the items in the order of the questionnaire, which is also attached. Within each row we have given details for the entire group as well as the (relatively small) subgroups. We used Spearman's Rho (a rank correlation coefficient) because the statistical distribution of the variables prevented the use the standard Correlation coefficient (needs normal distribution). Success items proved to be a valid and a reliable (Cronbach alpha) measure of innovation success. For a discussion of alternative models we refer to Meinhard (2002).

At first view the pattern of the correlation coefficients in the table might suggest huge differences. They are highest for the university only subgroup (many bivariate relationships stronger than 0.7). For the other subgroups the correlation coefficients are moderate to very low. Yet this pattern of differences is not to maintain statistically – as already stated above. We therefore discuss what might look as an intuitive result not under this section of results but rather under implications for future research.

**4. Implications**

**4.1 Limitations and implications for further research**

The question of timing remains a general issue in evaluating innovation success. At the end of four to six years of network participation some judgment of innovation success is certainly feasible. The items measuring innovation success are derived from respondent's ratings. Therefore especially economic success should not be mistaken as an ex-post measure of innovation outcome.

We only tested for linear relationships. The fact that some bivariate relationships are not very strong does not suggest, that there is no relationship. Sample size and statistical distribution of the data prevented tests for non-linear relationships.

The analysis would definitely profit from a multi-item scale for the 'Triple Helix cultural dimension'. The validity of the descriptors measuring the GUI / triple helix subgroups is unknown. As already stated we have derived the status of a network from publicly available sources for the entire network where the respondent was working in. Maybe or almost certainly only small fractions / cultures within those networks are relevant for the actual innovation-related task outcome / performance rating of a single researcher. We cannot assess reliability. Yet low reliability does not seem the problem – otherwise correlation coefficients above 0.7 could not be achieved.

Our assumption of a culture clash (see charts 1 and 2) is of highly speculative nature – (the 'huge' differences among the bivariate Spearman's Rank Correlation coefficients are not significant statistically).

We take this as a starting point for outlining future research needs.

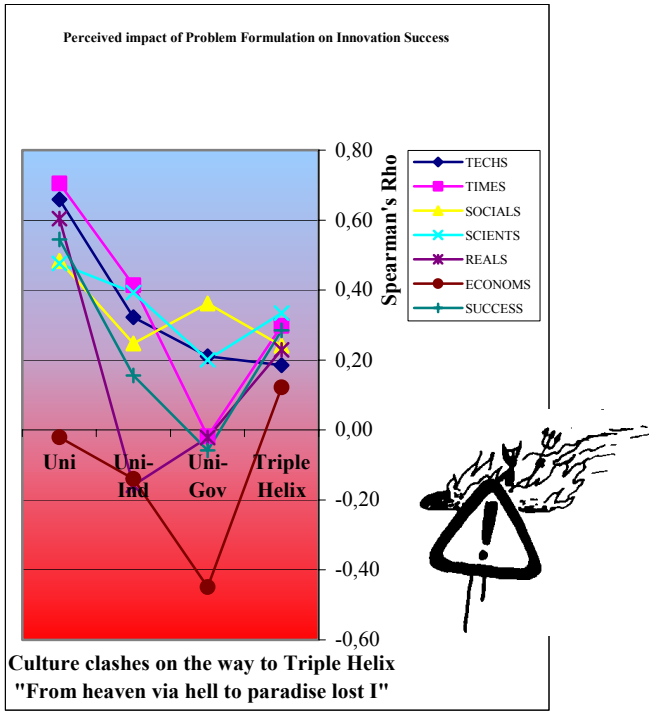


**Chart 1:** Relationships between problem formulation and six measures of innovation success.
[Differences are statistically not significant]

Both charts are rather of a programmatic nature than of a descriptive one. Should an academic research network add culturally different groups (industry, governmental users) sequentially, perceived predictability and community coordination ('management') become similar to a roller-coaster ride. We made the background colour fading from a heavenly competent blue into an alerting red (at least for most European cultures).

Controlling for spurious correlation. The at first look manipulative framing of four subgroups as a time series raises the issue of a stage-model for knowledge and

technologies. Perhaps it is not so much the culture change due to increased diversity in the population but rather issues of path-dependence and focussing a new technology's potential down the way to applications (c.f. Jolly; yet see also critique of stage models and linear technology incubation models).

Perhaps the differences are simply due to measurement dynamics when measuring change (alpha beta gamma change; cf. Tennis (1989), Thompson (1996), Dowling (2001)).

Due to the effect that the data set of 160 respondents becomes quickly too small when you split it up into different technology stages and cultural contexts we cannot fully analyse this issue of cultural impacts. This remains to be done in larger populations.

### 4.2 managerial implications

Let us assume that respondents related their ratings in some way to the underlying relationships between contexts, input variables and success dimensions. Then these Spearman's rho correlation coefficients can be seen as a proxy measure for the perceived predictability of innovation-related process models and contingencies within a specific culture.

Let us also assume the differences between cultural subgroups were statistically significant. Then purely academic networks are the only culture where it seems relatively easy to predict what leads to a certain innovation outcome / innovation success. 18 coefficients for bivariate relationships with the university-only subgroup are strong (>0.7) and statistically significant.

However once you integrate all three players (GUI) the correlation factors drop to a level where most of the time nothing can be predicted on a similar level. Within this group most bivariate linear relationships turned out to be weaker.

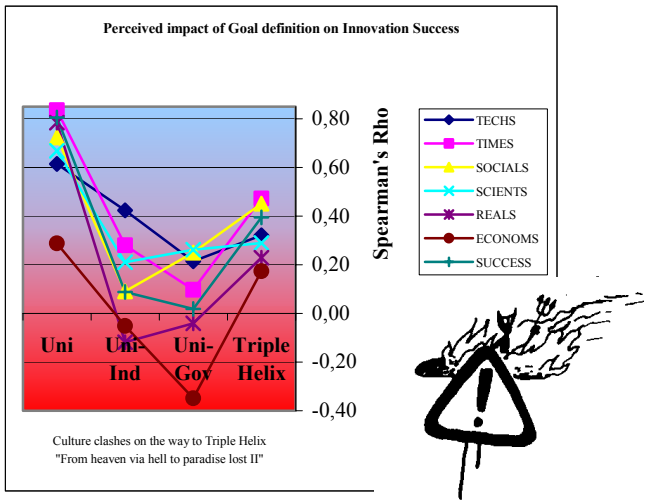


**Chart 2:** Relationships between goal definition and six measures of innovation success.
[Differences are statistically not significant]

When trying to speed up the incubation process of new technologies are we - as a society as well as in our role as experts to governing bodies - simultaneously driving the best of our experts out of heaven? The best of our experts in that sense that they (in those European networks C.O.S.T.) have proven to be successful in acquiring external research money nationally and on top of this contribute to an exchange of early results on a European scale. Within COST they even collaborate on a specified action plan to advance their technologies under a rather pure bottom-up mechanism. This helps to maintain diversity and to reduce blind spots.

Is non-sequential integration of the Triple Helix subgroups a way out? This would be similar to a born-global metaphor for some high-technology start-ups. Maybe once you scaled down cultural complexity it is difficult to scale it up again. Maybe this is the relationship between this research and problems in 'transferring technology / knowledge' or commercialising technology. Perhaps this is one of the unavoidable consequences for peripheral experts.

(Cross / Prosak, 2002)

Why the data behind the charts is far more important to us than what its statistical non-significance would suggest:

We did not ask for the respondent's perception of government integration (U-G and GUI triple helix). The questionnaire design was framed and laid out under a team-task metaphor within international collaborative network structures.

Therefore we assume that the underlying relationship is even more relevant than within a frame of reference where we would have asked "Within your specific experience in your COST network how do you perceive the impact of interested participants from industry or governments coming in". Or even more distant attributions "How would you generally perceive the influence of industry and government representatives joining formerly pure academic research communities".

In brief the data behind the charts helps to consciously reflect what seems to be politically incorrect nowadays – that the researchers we all depend on need their time for maintaining their leading-edge expertise. That these researchers feel it is detrimental if we overboard them with expectations into boundary-role spanning, cross-functional teams and advancing new knowledge scientifically as well as commercially at the same time.

**5. Conclusion**

On the one hand you need the Triple Helix for successful innovation. On the other hand you need 'peripheral experts' in academic research institutions as one important source for future innovation. How does the culture of leading-edge academic communities interfere with 'the need for the Triple Helix integration'? This is what we have investigated here. In our discussion of implications we have introduced two metaphors. One was 'From heaven via hell to paradise lost.' The other more implicit one was that if culture effects innovation success we better acknowledge researcher's need for homogeneity instead of driving them out of heaven.

Both metaphors are guiding principles for both our future research as well as our daily practice when it comes to speeding-up successful commercialisation of innovative knowledge and new technologies.

## 6. Table of bivariate Rank Correlation Coefficients (Spearman's rho)

| Page 1 of 2 | | Dimensions of successful problem solving in innovation problems | | | | | | Overall |
|---|---|---|---|---|---|---|---|---|
| Spearman's Rho | subgroup | TECHS | TIMES | SOCIALS | SCIENTS | REALS | ECONOMS | SUCCESS |
| INTERDIS | Entire sample | 0,01 | 0,08 | 0,12 | 0,08 | 0,18* | 0,22** | 0,18* |
| | Triple Helix | -0,11 | 0,02 | 0,17 | 0,04 | 0,24* | 0,28* | 0,21 |
| | Uni-Gov | 0,16 | -0,15 | 0,09 | -0,08 | -0,15 | -0,01 | -0,19 |
| | Uni-Ind | 0,06 | 0,19 | 0,19 | 0,20 | 0,11 | 0,26 | **0,32*** |
| | Uni | -0,02 | 0,24 | 0,13 | **0,34** | **0,58*** | **0,52** | 0,29 |
| INDUSTRY | Entire sample | 0,23** | 0,12 | 0,03 | -0,03 | 0,14 | **0,38**** | 0,28** |
| | Triple Helix | **0,33**** | 0,05 | 0,09 | 0,11 | 0,13 | 0,27* | 0,28* |
| | Uni-Gov | 0,18 | **0,57**** | 0,23 | **-0,35** | 0,06 | **0,30** | 0,25 |
| | Uni-Ind | 0,00 | -0,09 | -0,18 | -0,11 | 0,25 | **0,67**** | 0,27 |
| | Uni | **0,67**** | **0,33** | 0,15 | 0,23 | 0,24 | 0,26 | **0,32** |
| LEAD | Entire sample | **0,39**** | **0,41**** | **0,35**** | 0,28** | 0,18* | 0,06 | **0,36**** |
| | Triple Helix | 0,27* | **0,40**** | 0,26* | 0,19 | 0,12 | 0,05 | 0,25* |
| | Uni-Gov | **0,36** | **0,32** | **0,45*** | **0,36** | **0,40*** | 0,10 | **0,46*** |
| | Uni-Ind | **0,45**** | **0,39**** | **0,44**** | **0,37**** | 0,10 | 0,08 | **0,45**** |
| | Uni | **0,88**** | **0,70**** | **0,43** | **0,37** | **0,47** | -0,04 | **0,55*** |
| INTEREST | Entire sample | 0,14 | 0,11 | **0,34**** | 0,23** | 0,19* | 0,20* | 0,27** |
| | Triple Helix | 0,13 | 0,15 | **0,37**** | 0,13 | 0,15 | **0,32**** | 0,28* |
| | Uni-Gov | 0,08 | 0,00 | 0,26 | 0,20 | 0,05 | 0,12 | 0,10 |
| | Uni-Ind | 0,12 | 0,08 | 0,25 | **0,29*** | 0,29* | 0,06 | **0,36*** |
| | Uni | **0,74**** | **0,51** | **0,49** | **0,41** | **0,31** | **0,37** | **0,47** |
| ENGAGE | Entire sample | **0,34**** | **0,35**** | **0,49**** | 0,28** | 0,19* | 0,18* | **0,41**** |
| | Triple Helix | **0,41**** | **0,45**** | **0,52**** | 0,19 | 0,17 | 0,24* | **0,44**** |
| | Uni-Gov | 0,18 | 0,23 | **0,39*** | **0,41*** | 0,24 | 0,13 | **0,31** |
| | Uni-Ind | 0,23 | 0,11 | **0,30*** | 0,22 | 0,12 | 0,13 | 0,27 |
| | Uni | **0,82**** | **0,76**** | **0,64*** | **0,54*** | **0,44** | 0,06 | **0,74**** |
| STEAMS | Entire sample | 0,09 | 0,18* | 0,26** | 0,16* | 0,07 | -0,16* | 0,05 |
| | Triple Helix | 0,08 | 0,19 | 0,24* | 0,01 | 0,06 | -0,16 | 0,00 |
| | Uni-Gov | -0,17 | -0,19 | **0,30** | **0,32** | 0,02 | -0,21 | -0,07 |
| | Uni-Ind | 0,14 | 0,27 | 0,28 | 0,19 | -0,07 | -0,21 | 0,05 |
| | Uni | **0,76**** | **0,66**** | **0,39** | **0,33** | **0,35** | 0,19 | **0,60*** |
| TRUST | Entire sample | 0,09 | 0,13 | **0,36**** | 0,21** | 0,10 | -0,02 | 0,18* |
| | Triple Helix | 0,14 | 0,15 | **0,30*** | 0,22 | 0,17 | 0,15 | 0,22 |
| | Uni-Gov | **-0,39*** | -0,27 | 0,27 | 0,08 | -0,19 | -0,27 | -0,25 |
| | Uni-Ind | 0,16 | 0,18 | **0,40**** | 0,08 | 0,08 | -0,20 | 0,26 |
| | Uni | **0,65*** | **0,61*** | **0,41** | **0,40** | **0,41** | 0,08 | **0,63*** |
| INFOCONT | Entire sample | 0,12 | 0,12 | 0,24** | 0,14 | 0,11 | 0,06 | 0,19 |
| | Triple Helix | 0,08 | 0,22 | 0,29* | 0,16 | 0,10 | 0,08 | 0,23 |
| | Uni-Gov | -0,10 | -0,10 | 0,00 | -0,12 | 0,03 | -0,28 | -0,09 |
| | Uni-Ind | 0,25 | 0,05 | 0,18 | 0,16 | 0,15 | 0,15 | **0,29*** |
| | Uni | **0,53*** | **0,33** | 0,26 | **0,30** | 0,16 | **0,50** | **0,39** |
| FUN | Entire sample | 0,25** | 0,27** | **0,53**** | 0,28** | 0,05 | 0,08 | **0,30**** |
| | Triple Helix | 0,26* | **0,32**** | **0,58**** | 0,28* | -0,02 | 0,19 | 0,29* |
| | Uni-Gov | **0,39*** | **0,41*** | **0,55**** | 0,27 | 0,24 | -0,09 | **0,44*** |
| | Uni-Ind | 0,08 | 0,04 | **0,39**** | 0,15 | -0,06 | -0,14 | 0,13 |
| | Uni | **0,56*** | **0,58*** | **0,53** | **0,70**** | **0,49** | **0,70**** | **0,73**** |

Table 1: Table of bivariate Rank Correlation Coefficients (Spearman's rho)
Entire sample n=163, Triple Helix n = 70, Uni-Gov n = 31, Uni-Ind n = 48, Uni n = 14.
* significant on the 0,05 level; ** significant on the 0,01 level

| Page 2 of 2 | | Dimensions of successful problem solving in innovation problems | | | | | | Overall |
|---|---|---|---|---|---|---|---|---|
| Spearman's Rho | subgroup | TECHS | TIMES | SOCIALS | SCIENTS | REALS | ECONOMS | SUCCESS |
| PERSEXCH | Entire sample | 0,23** | 0,21** | **0,36**** | **0,41**** | 0,15 | 0,08 | **0,32**** |
| | Triple Helix | 0,18 | 0,23 | **0,35**** | **0,48**** | 0,19 | 0,24* | **0,39**** |
| | Uni-Gov | **0,34** | 0,26 | 0,27 | 0,26 | 0,21 | 0,04 | **0,37*** |
| | Uni-Ind | **0,34*** | 0,17 | **0,42**** | 0,22 | 0,02 | **-0,32*** | 0,07 |
| | Uni | **0,43** | **0,49** | **0,62*** | **0,82**** | **0,67**** | **0,37** | **0,73**** |
| PROBFORM | Entire sample | 0,26** | **0,30**** | 0,26** | **0,33**** | 0,10 | -0,07 | 0,22** |
| | Triple Helix | 0,19 | **0,30*** | 0,24* | **0,33**** | 0,23 | 0,12 | 0,29* |
| | Uni-Gov | 0,21 | -0,02 | **0,36*** | 0,20 | -0,02 | **-0,45*** | -0,06 |
| | Uni-Ind | **0,32*** | **0,41**** | 0,25 | **0,39**** | -0,16 | -0,14 | 0,16 |
| | Uni | **0,66**** | **0,71**** | **0,48** | **0,48** | **0,60*** | -0,02 | **0,55*** |
| GOALDEF | Entire sample | **0,35**** | **0,39**** | **0,35**** | 0,28** | 0,14 | 0,02 | **0,30**** |
| | Triple Helix | **0,32**** | **0,47**** | **0,45**** | 0,29* | 0,23 | 0,17 | **0,40**** |
| | Uni-Gov | 0,21 | 0,10 | 0,25 | 0,26 | -0,04 | **-0,35** | 0,02 |
| | Uni-Ind | **0,42**** | 0,28 | 0,09 | 0,21 | -0,12 | -0,05 | 0,09 |
| | Uni | **0,61*** | **0,84**** | **0,72*** | **0,67*** | **0,78**** | 0,29 | **0,81**** |
| PERSCONT | Entire sample | 0,26** | 0,24** | **0,39**** | **0,34**** | 0,15 | 0,15 | **0,38**** |
| | Triple Helix | **0,30**** | **0,45**** | **0,43**** | **0,33**** | 0,13 | 0,21 | **0,46**** |
| | Uni-Gov | **0,51**** | 0,10 | **0,41*** | **0,35** | 0,25 | -0,25 | 0,27 |
| | Uni-Ind | 0,12 | 0,03 | 0,26 | 0,24 | 0,16 | 0,14 | **0,34*** |
| | Uni | 0,10 | **0,38** | **0,42** | **0,49** | **0,49** | **0,70**** | **0,56*** |
| COMPET | Entire sample | 0,07 | 0,03 | -0,06 | 0,04 | 0,00 | 0,02 | 0,02 |
| | Triple Helix | -0,03 | -0,08 | -0,11 | 0,02 | -0,02 | 0,14 | 0,03 |
| | Uni-Gov | 0,20 | 0,17 | 0,14 | 0,04 | 0,05 | -0,11 | 0,11 |
| | Uni-Ind | 0,19 | 0,16 | -0,03 | 0,14 | 0,01 | -0,13 | 0,01 |
| | Uni | -0,20 | -0,16 | **-0,42** | **-0,34** | **-0,31** | **0,46** | -0,22 |
| CLUSTER | Entire sample | 0,11 | 0,16* | **,221*** | 0,16* | 0,06 | 0,01 | 0,15* |
| | Triple Helix | 0,19 | 0,22 | 0,25* | 0,24* | 0,02 | 0,02 | 0,19 |
| | Uni-Gov | 0,07 | 0,21 | 0,04 | -0,10 | -0,03 | -0,02 | 0,11 |
| | Uni-Ind | 0,13 | 0,08 | **0,36*** | 0,27 | 0,18 | 0,04 | **0,31*** |
| | Uni | 0,04 | 0,06 | -0,06 | -0,27 | **-0,33** | -0,04 | -0,21 |
| EXCHKNOW | Entire sample | 0,16* | **,244*** | **0,38**** | 0,19** | 0,03 | -0,10 | 0,18* |
| | Triple Helix | 0,20 | 0,26* | **0,47**** | **0,30*** | 0,01 | -0,04 | 0,20 |
| | Uni-Gov | 0,02 | 0,10 | 0,13 | -0,10 | -0,01 | -0,18 | 0,03 |
| | Uni-Ind | 0,12 | 0,28 | **0,38**** | 0,14 | 0,03 | -0,12 | 0,16 |
| | Uni | **0,57*** | 0,29 | 0,22 | 0,24 | 0,28 | -0,14 | 0,22 |
| EXCHEXP | Entire sample | 0,10 | 0,09 | 0,28** | 0,19* | 0,07 | -0,04 | 0,15 |
| | Triple Helix | 0,17 | 0,20 | 0,27* | 0,20 | -0,08 | 0,03 | 0,15 |
| | Uni-Gov | **0,29** | 0,05 | **0,41*** | 0,02 | 0,25 | -0,25 | 0,23 |
| | Uni-Ind | -0,06 | -0,01 | 0,25 | 0,19 | 0,17 | 0,05 | 0,19 |
| | Uni | 0,26 | 0,01 | 0,23 | 0,21 | -0,11 | -0,15 | -0,02 |
| CREATIVE | Entire sample | 0,15 | 0,05 | 0,05 | 0,11 | -0,04 | 0,04 | 0,07 |
| | Triple Helix | 0,08 | -0,05 | -0,06 | -0,01 | -0,20 | 0,04 | -0,06 |
| | Uni-Gov | -0,11 | -0,12 | -0,13 | -0,16 | -0,20 | -0,05 | -0,17 |
| | Uni-Ind | **0,35*** | 0,18 | 0,16 | **0,32*** | 0,15 | 0,12 | **0,31*** |
| | Uni | 0,26 | **0,46** | **0,60*** | **0,47** | **0,57*** | -0,12 | **0,46** |

Table 1 continued: Table of bivariate Rank Correlation Coefficients (Spearman's rho)
Entire sample n=163, Triple Helix n = 70, Uni-Gov n = 31, Uni-Ind n = 48, Uni n = 14
* significant on the 0,05 level; ** significant on the 0,01 level

**7. Questionnaire "Successful Problem Solving in COST"** [Layout might slightly change]

Below please find 32 questions concerning the COST action you participated in. Please answer them by ticking the boxes representing your COST experiences best. The completion of the whole questionnaire will take a maximum of about 15 minutes. Of course, all the information will be handled anonymously in order to complete my thesis only; Data will not be disclosed to any other party. Finally, please do not forget to **save** the completed questionnaire and to **send** it back to dieter.meinhard@wu-wien.ac.at. **Thank you very much!**

**General questions.**

1. According to the official COST database you were participating in a COST action which was completed during the past two years (2000, 2001). Is this correct?

☐ Yes

☐ No

*If your answer is no, please return the questionnaire uncompleted.*

2. What was your role in the COST action?

*If both answers are valid please tick all of them.*

☐ Management Committee Member.

☐ Working Group Member.

3. Did the COST team aim to solve an existing problem?

Generally a problem is defined as a situation, which is characterised by an unsatisfactory initial state which should be transformed into a more satisfactory target state. This transformation is not feasible immediately (without a problem).

☐ Yes, the COST action aimed to solve an existing problem.

☐ No, the COST action did not aim to solve an existing problem.

4. How complex was the innovation process in the course of the COST action?

Below the complexity of innovation processes is clustered in the following three groups.

☐ The innovative problem solution was available for another context and was transferred into the context of the COST action. The adaptation to the new context was performed by the COST team.

☐ Available parts of the innovative problem solution were combined by the COST team.

☐ The innovative problem solution did not exist and had to be developed by the COST team.



5. Which technology stage was mainly addressed by the COST action?

*If more than one answer is valid please tick all of them.*

☐ Idea generation.

☐ Problem formulation.

☐ Basic research.

☐ Demonstration.

☐ Standardisation.

☐ Marketing / promotion.

☐ Market adoption.

6. Which of the two aspects mentioned below was the core focus of the COST action?

☐ Methodical aspects (rather basic research was addressed).

☐ Application aspects (rather applied research was addressed).

**The following questions concern the success generated by the COST action.**

7. Did the COST action bring about a technical success?

A technical success is achieved when technical problems addressed by the COST team have been solved on a high quality level.

| | *No Focus* | Very Low | Low | Medium | *High* | Very High | Total |
|---|---|---|---|---|---|---|---|
| Technical success | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

8. Did the COST action generate a success in terms of time?

A success in terms of time is achieved when the COST team have been met the action timeline.

| | *No Focus* | Very Low | Low | Medium | *High* | Very High | Total |
|---|---|---|---|---|---|---|---|
| Success in terms of time | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

9. Did the COST action excel in terms of social success?

A social success is achieved when a perfect climate of co-operation and trust has been established in the course of the COST action.

| | *No Focus* | Very Low | Low | Medium | *High* | Very High | Total |
|---|---|---|---|---|---|---|---|
| Social success | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

10. Was the COST action a scientific success?

A scientific success is achieved when a lot of publications, dissertations, habilitations, patents, etc. have been generated by the COST team.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Scientific success | *No Focus* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Total ☐ |

11. Was the COST action a success in terms of realisation?

A realisation success is achieved when an operational product or service has been developed by the COST team .

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Realisation success | *No Focus* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Total ☐ |

12. Did the COST action generate an economic success?

An economic success is achieved when a reduction of costs, an increase of revenues, etc. have been realised by the cost team.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Economic success | *No Focus* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Total ☐ |

**The following questions concern the members of your COST team.**

13. Was the COST team an interdisciplinary one?

A team is interdisciplinary when group members from different scientific disciplines (natural science, social science, economics, etc.) are involved. It is not interdisciplinary when persons from only one scientific discipline (e.g. natural science) are participating.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Interdisciplinarity of the team | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

14. To what extend did representatives from industry participate in the COST team?

A team member is actively participating in the COST activities. Therefore, industry representatives “only” visiting COST meetings without providing actual contributions to the work performed in COST are not dealt with in this question.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Industry participation | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |



15. How was leadership quality in your COST action?

The leadership quality of a COST action depends mainly on the overall quality of work performed by the Management Committee and the Working Group Chairs.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Quality of leadership | *Bad* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Perfect ☐ |

16. Did the COST team explicitly integrate opinions of interest groups?

In this study interest groups are defined as persons who are not directly participating in a COST action but do have interest in the activities of the COST team.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Integration of interest groups | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

17. How was the personal engagement of the COST team members?

Here personal engagement is mainly based on the individual commitment of the persons involved in the COST team. Such a commitment results in activities of the participants also without external incentives (e.g. additional money).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Personal engagement | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

**The following questions concern the interaction between the COST team members.**

18. Did the COST network perform most of the work in small teams?

In this study small teams are characterised by a maximum of seven to ten team members, performing parts of the COST work in such a group.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Work performed in small teams | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

19. How was trust between the persons in the COST group?

In a variety of studies trust is seen as one primary driver for an actual co-operation between different persons including a wide-spread knowledge exchange.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Trust between team members | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

20. Did the COST team mainly communicate in a lot of informal contacts?

Here informal contacts are defined as interactions between COST team members which other parties are not necessarily aware of.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Informal contacts | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

21. Did the COST members have a lot of fun during their participation?

In particular fun is seen as a driving success factor for network activities performed in an environment where less external incentives (e.g. additional research money) are provided. COST is seen as such a network.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fun during participation | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

22. Did the participating organisations exchange a lot of personnel during the COST action?

One form of such exchange in the course of a COST action is the so called "Short Term Scientific Mission".

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Exchange of personnel | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

**The following questions concern the problem solving process during the COST action.**

23. Did the COST team explicitly formulate the main problem which has to be solved?

The overall formulation of a problem contains the existing unsatisfactory initial state, the desired target state and some ideas how to get from the initial to the target state.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Formulation of the main problem | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

24. Did the team define common, clear and exact goals of the COST action?

Such a goal definition should be developed in an interactive process and results in its formulation in a clear and exact manner.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Definition of action goals | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |



25. Did the team members have a lot of personal contacts during the COST action?

Here particularly those contacts which took place outside the regular meetings are meant.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Personal contacts outside the meetings | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

26. How was competition between team members in the COST action?

In this study competition is defined as a contest for thematic knowledge, rare projects following the cost action, rare industry representatives participating in the COST action, etc.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Competition between members | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

27. Was the COST action part of larger clustering activities / networking activities?

In this context clustering is taking place when different activities (projects) in one thematic field are brought together to allow for an intensive knowledge exchange between them. Also projects outside COST can be included in such cluster activities.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Clustering of different activities | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

**The following questions concern problem solving patterns encountered by the team.**

28. Did the COST members exchange a lot of thematic knowledge during the action?

Here exchange of knowledge is defined as the sharing of thematic experiences, former results, data, methods, etc. between the COST participants.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Exchange of thematic knowledge | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

29. Did the COST members exchange a lot of experiences concerning work in networks?

Experiences meant in this question are those concerning the actual work in networks, not thematic experiences. Therefore, these experiences are rather process oriented.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Exchange of network experiences | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

30. Did the COST team mainly use algorithms to solve the problems addressed?

Algorithms are problem solving procedures applicable in a specific thematic field. They guarantee a problem solution if used correctly (e.g. mathematics equation). Therefore, algorithms are mainly executed in case the team exactly knows how to solve the problem.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Usage of algorithms | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

31. Did the COST team mainly use heuristics to solve the problems addressed?

Heuristics are problem solving procedures applicable in different thematic fields. They do not guarantee a problem solution (e.g. systematic trial and error approach). Therefore, heuristics are mainly used in case the team does not exactly know how to solve the problem.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Usage of heuristics | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

32. Did the COST team mainly use creative techniques to solve the problems addressed?

Creative techniques are problem solving procedures mainly used in case the target state of the problem is not defined exactly. By applying them, new alternatives are likely to be identified.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Usage of creative techniques | *Non* ☐ | Very Low ☐ | Low ☐ | Medium ☐ | *High* ☐ | Very High ☐ | Entire ☐ |

**Only one aspect has not been addressed yet ...**

33. Would you like to receive an executive summary of the results generated during the thesis? If yes, please tick the following box: ☐

Thank you very much for **saving and sending**
the completed questionnaire back to dieter.meinhard@wu-wien.ac.at.



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