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# Teaching the Chief Information Officers: An Assessment of the Interrelations within their Skill Set

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**Abstract.** Due to the high volatility in the field of information technology (IT) and the rapid technological advancements, all IT professionals constantly have to be able to evaluate trends and put them into context. This is especially true for those who fulfill the role of a company's chief information officer (CIO). But if there is a gap between the required set of skills and those needed, training becomes necessary. In order to plan training programs, one has to know the skill set of current CIOs. We investigate this by conducting workshops with 21 CIOs from a diverse set of companies. The purpose of this paper is to better understand the skill items of CIOs and how they interrelate.

**Keywords:** CIO, training, skill gap, interrelation analysis

## 1 Motivation

In times of economic uncertainty, constant change has become the norm: volatility, multiplicity, versatility, and mobility are the 2012 mega trends for information technology (IT) professionals [1]. In order to cope with these trends, IT staff has to keep track of technological developments and decide if and how to adopt them [2]. The rapid technological advancements multiply the complexity and increase the need for personnel with appropriate knowledge and skills [3]. But a one-size-fits-all approach for training IT personnel is bound to fail as different skills are required during an individual's career [3]. The relative importance of technical, personal, administrative and conceptual skills changes over time [4]. However, most IT training programs are still targeted at starters and pure technical skills whilst neglecting skills required for leadership positions with their lifelong learning requirement [5].

As IT is now part of the very fabric of modern life and business, the management of IT also gains importance [6-7]. Management of IT means the alignment of IT and business requirements and the linkage of the organizational strategy to the IT strategy [8-9]. IT management is usually the task of the information systems (IS) function within a company, headed by the Chief Information Officer (CIO) [10]. While in the U.S. the name CIO is widely accepted for this strategic position, in Europe often the title IT director is used to describe a more operational role. In this paper we follow the



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understanding of Joia and define the CIO as the IT professional that is leading the organizational unit responsible for IT within an organization [10].

It is no wonder that CIOs need to have a broad set of skills to excel in their job [2]. In literature, broad skill categories for CIOs, like knowledge and managerial skills [11], technical and non-technical skills [12], project management skills [13], IT capabilities and well-honed communication skills [14], are named. In most cases, they are based on theoretical models [9], [15]. However, these models describe required skills only on a very high abstraction level.

To plan an actual training curriculum, these broad categories do not provide the required level of detail nor do they necessarily reflect the skill levels of current CIOs. Therefore, a concretization and derivation of interrelations between current skills is necessary for planning comprehensive training programs [3]. Hence, we derived the following research question:

*RQ: What are skill items current CIOs possess and how are they interrelated?*

In order to answer our research question, we proceed as follows: Based on a comprehensive literature review [16], we conduct two workshops. Due to the exploratory nature of our research this procedure has been chosen instead of conducting a Delphi study or large-scale survey. After presenting the key results, implications are discussed and a conclusion and outlook are given.

## 2 Background

Usually, the term skill is used interchangeably with the concept of competence [7]. However, there is a subtle difference: While skills are defined as the ability to apply knowledge and use know-how to complete tasks and solve problems, competencies are the proven ability to use knowledge, skills and personal, social, and/or methodological abilities, in work or study situations and in professional and personal development [17]. In the following we use the term skill to stress that the described abilities have not yet been proven.

In literature, skills are usually divided into technical (hard) and personal (soft) skills [18]. Hard skills, like programming, become less and less important, and companies increasingly emphasize soft skills, like leadership skills, when hiring new IT personnel [19-20].

A mixture of different kinds of skills is necessary for CIOs [14], [18]. Back in 1983, Zmud described general skill categories IT professionals should fulfill: Next to organizational (unit) knowledge and skills, which generally are seen as soft, “hard” IS knowledge and technical skills are required [21]. Throughout the years, those skill lists have been extended and adapted to the specific role of the CIO. Later research also stressed the economic importance of the CIO [11]. Joia went further by integrating six models of CIO skills, like Earl [9] or Broadbent and Kitzis [15], into one. Additionally, a questionnaire had been sent by Joia to (Brazilian) CIOs for verification. The resulting skill categories are knowledge of the business, understanding the organ-

izational context, ability to influence the organization, technical expertise, external networking, management of the IT operation, and capacity to innovate using new IT [10]. Other authors like Ekimci and Ozkan [22], Luftman and Ben-Zvi [23], or Peppard [7] use similar skill categories for their research. What most approaches have in common is that they use general skill listings without analyzing skills in concrete technologies or methods.

Since 1991, CIGREF has been developing a nomenclature of IS roles which provides a description of the roles existing in the IT Departments. It consists of 36 competences which are associated to 33 roles of IT professionals [24]. One of these roles is the Chief Information Officer (CIO) (cf. Table 1). This to-be profile consists of 10 general skill categories (and associated levels of proficiency and responsibility) a CIO should fulfill. Nevertheless, one has to keep in mind that these items are not the skills which CIOs actually possess.

**Table 1.** To-be profile of the CIO role [24]

| Areas of concern | General skill category | Level |
|---|---|---|
| Plan | IS and Business Strategy Alignment | 5 |
| | Service Level Management | 4 |
| | Business Plan Development | 5 |
| | Sustainable Development | 4 |
| Enable | Personnel Development | 4 |
| Manage | Risk Management | 3 |
| | Relationship Management | 4 |
| | Business Change Management | 5 |
| | Information Security Management | 3 |
| | IT Governance | 5 |

One of the key challenges in the IT environment is the transformation of technically skilled entry-level hires into midlevel IT managers with strong business management skills [25]. In order to achieve this, comprehensive training programs [26] are necessary that implement the requirements of CIGREF. Boehm et al. developed such an approach for teaching CIOs. Their framework (cf. Figure 1) is based on an iterative assessment of 116 existing training programs together with expert interviews of researchers and practitioners. The authors identified core modules which can be grouped into methodology courses and personal skills modules [27].

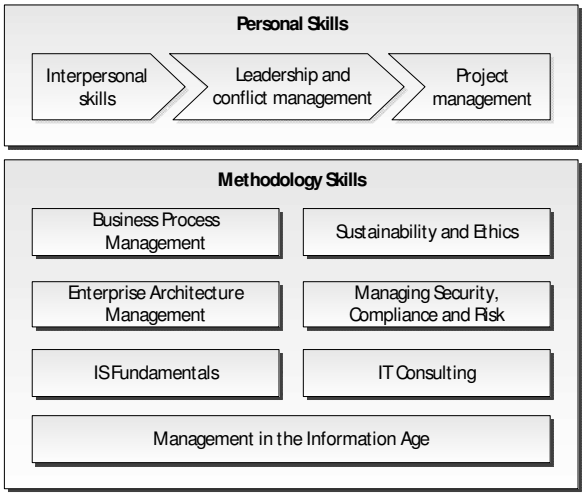


**Fig. 1.** Framework for Teaching CIOs [27]

The first methodology module, Management in the Information Age (MIA), integrates aspects like internet economics, management basics as well as consulting methods and approaches. In the field of IS Fundamentals (ISF), the basics of IS/IT, enterprise software, business intelligence, and operations research are covered. Enterprise Architecture Management (EAM) discusses all aspects of Business-IT alignment and IT service management. Process-oriented approaches and methods belong to the field of Business Process Management (BPM). The IT Consulting (ITC) module focuses on knowledge and methods related to business and IT advice. Within the field of Managing Security, Compliance and Risk (MSCR) subjects like IT security, legislation, contracts, and risk management are discussed. Sustainability and Ethics (SE) deal with green IT, management ethics, and social aspects of information management as well as intercultural studies. Finally, the personal skill modules cover aspects on Interpersonal skills, Leadership and conflict management as well as Project management. The modules in the framework can be seen as concrete skills for CIOs and, therefore, these skill items will be used in further analysis of the CIOs' skills [3].

## 3 Methodology

For answering our initially laid out research question, we conduct a multi-perspective analysis. For doing so, several research methods could have been employed. With the help of a large-scale survey among CIOs, one could identify nearly all skills of CIOs. A Delphi study could be used to identify research and practice agendas for training certain skills. We decided to employ neither of these two methods. There are several reasons for this decision: Next to time and resource related reasons, the main reason has been the fact that we wanted to closely get in touch with the CIOs. We are convinced that thorough discussions are more helpful in answering our research questions

than large-scale studies [28]. Hence, we considered the workshop method as ideal for our investigation. Although the analyzed phenomenon is hardly nascent, we chose this method because it allowed us to discuss the answers of the CIOs, to give context to answers, and to iterate on the given answers several times.

The data collection took place in two workshops – one in June 2011 and one at the end of 2011. Next to comprehensive group discussions, qualitative and quantitative instruments were employed.

The self-reporting approach of Vygotsky is used for methodological foundation. This is a process of looking at the self in order to consider aspects that one is asked to evaluate. Participants are asked to respond to a set of survey questions which rate their own knowledge, expertise, or skills [29]. This instrument is seen as a valuable depiction of the reality, although there are the limitations like overestimating or underestimating the level of expertise [30]. Nevertheless, it is claimed that the self-reporting approach, for example in form of think-aloud protocols of experts, can be seen as a good instrument for the study of skills [31].

Within the first workshop, the skill lists found in literature have been worked on with eight experts from practice. Besides three CIOs, we invited two executive level managers, two department managers and one executive coach to gain a 360 degree view on the topic. Within the workshop advantages and disadvantages of various approaches have been discussed by the two women and six men. Furthermore, the participants have been asked to further elaborate on required skills.

The second workshop was attended by twenty-one CIOs from different industries. Except for one, all have been male. The aim of this meeting was the self-assessment of skills. For doing so, we developed a questionnaire which is based on our literature analysis and the first workshop. The participants have been asked to fill out the first questionnaire. In this questionnaire, the CIOs assessed their skills on a 5-point Likert-type scale. Within the analysis, the aim is to investigate relationships between skills. This can help to design more integrated programs addressing interconnected skills better. As the variables are ordinal ranked, a specific measure for correlation to identify interconnections has to be selected. We chose Kendall's $\tau_B$ because it is as powerful as the traditional Pearson coefficient but is explicitly tailored to ordinal variables and more useful for smaller sample sizes [32]. Kendall's $\tau$ correlation coefficients do not reflect to what extent two variables move together. Rather, they assess the difference between the probabilities that the observed data are in the same order versus the probability that the observed data are not in the same order. In other words, it assesses the association between the rankings applied to the different variables (the similarity of data orderings).

### 3.1 Psychometric Properties

In order to show how well our instrument measures the construct of interest, we calculated its psychometric properties. In general, there are two broad types of psychometric properties: reliability and validity. In order to ensure the appropriateness of our research instrument, we tested it for reliability and content validity.

Reliability refers to the internal consistency of a measurement instrument. It means that a measure (in our case the questionnaire) consistently reflect the construct that it is measuring. Therefore, it is the test's ability to measure the construct of interest consistently. Mostly, the Cronbach's α is used here, whereas it should be higher than .8 in order to be accepted [33]. In our case, Cronbach's α equals .841, which can be seen as high reliability.

Validity in general refers to whether an instrument measures what it was designed to measure. It is the question of how well the test accurately measures the construct of interest. In order to accept the validity of the observed measurement, there are major estimation methods: construct, content, concurrent and predictive validity. Construct validity involves understanding the theoretical rationale underlying the obtained measurements and hence relates the construct of interest to other constructs in order to develop an entire theoretical framework for the phenomenon being measured [34]. Concurrent validity involves correlating two different measurements of the same phenomenon. Predictive validity refers to the ability of a measured phenomenon at one point in time to predict another phenomenon at a future point. Content validity is the evidence that the content of a test corresponds to the content of the construct it was designed to cover. As this research concentrates on one concept and uses one concept at one specific point in time, only content validity can be examined in the following.

For this purpose, experts can be consulted. In order to ensure content validity, a comprehensive literature review on skills of CIOs was conducted. Within a pre-test, the questionnaire was filled out by experts (professors and IS professionals). They reviewed it and gave helpful comments on how to change the questionnaire. Therefore, both content and clarity could be improved. Finally, a sample of respondents (separate from those included in the pre-test) was asked to check the questionnaire. These and all pre-test respondents were excluded from the sample used for data analysis.

## 4 Results

The participants of the first workshop confirmed that the chosen framework by Boehm et al. [27] is valid. They concluded that the modules of the framework can be seen as general skill categories. Next to these ten skills, the following nine important skill categories have been added to the list: IT Governance (ITG), Cloud Computing (CC), Outsourcing (Out), Virtualization (Vir), (Process) Modeling (Mod), Customer and Employee Satisfaction (Sat), Coaching (Coa), Enterprise Resource Planning (ERP), and IT Training (ITT). These skills are also seen as highly relevant for CIOs in literature (cf. for example [20], [22], [35–38]).

One can remark that the skills of the framework by Boehm et al. [27] and those of the participants exist at different levels of analysis. For example, ERP (one category identified by the participants) could fit within the IS Fundamentals category identified by Boehm et al. [27]. Therefore, participants of the workshop elaborated together with the authors an integrated list of skills (cf. Table 2). In this list the level of analysis has been defined for each skill. For example, while the skill Enterprise Resource Planning

is seen on a specific and practical level, IS Fundamentals is seen on a more general and theoretical level. Altogether, skills can be defined on a general, theoretical, specific and/or practical level. With this list we ensure the comparability of skills.

**Table 2.** Integrated List of Skills

| Skill | Source | Level of Analysis |
|---|---|---|
| Management in the Information Age | Boehm et al. [27] | General and theoretical |
| IS Fundamentals | Boehm et al. [27] | General and theoretical |
| IT Consulting | Boehm et al. [27] | Theoretical and practical |
| Enterprise Architecture Management | Boehm et al. [27] | General and theoretical |
| Business Process Management | Boehm et al. [27] | Theoretical |
| Managing Security, Compliance and Risk | Boehm et al. [27] | Theoretical and practical |
| Sustainability and Ethics | Boehm et al. [27] | General and theoretical |
| IT Governance | 1st Workshop | Specific and practical |
| Cloud Computing | 1st Workshop | Practical |
| Outsourcing | 1st Workshop | Practical |
| Virtualization | 1st Workshop | Specific and practical |
| Modeling | 1st Workshop | Specific and practical |
| Customer and Employee Satisfaction | 1st Workshop | Practical |
| Enterprise Resource Planning | 1st Workshop | Specific and practical |
| Coaching | 1st Workshop | Theoretical and practical |
| IT Training | 1st Workshop | Theoretical and practical |
| Interpersonal Skills | Boehm et al. [27] | Theoretical and practical |
| Leadership Management | Boehm et al. [27] | Theoretical and practical |
| Project Management | Boehm et al. [27] | Practical |

From the 21 CIOs of the second workshop, 17 questionnaires have been completely filled out and therefore could be used for the analysis. All respondents are male and their average age is 39.44, with the youngest participant being 30 years old and the oldest 56. Although most participants have different job titles, their position can be basically subsumed by the term CIO. Nearly 53% of the participants' enterprises have less than 250 employees. These firms can be seen as small or medium-sized enterprises (SMEs). However, also a relatively large amount of participants (35%) comes from companies with more than 1,000 employees. The business sectors have been compiled using the North American Industry Classification System (NAICS). According to this system, half of the CIOs come from companies offering professional, scientific, and technical services (50%). In 32% of the cases, CIOs work at manufacturing companies, followed by enterprises working in the field of agriculture, forestry, fishing, and hunting (12%). One CIO works at a real estate company (6%). Altogether, one can say that the participants of the workshops reflect to a good extent the global market in terms of size of enterprises and business sectors.

The results of the CIO self-assessment of the 19 final skills which took place in the second workshop are depicted in Figure 2. The skills have been coded from -2 (= lowest rank) to 2 (= highest rank). For each skill its abbreviation (Abb.), average value (Avg.), standard deviation (SD) and rank is shown in the left part of Figure 2. The right part shows a graphical representation of the average values.

| Skill | Abb. | Avg. | SD | Rank |
|---|---|---|---|---|
| Management in the Information Age | MIA | ,65 | ,996 | 5 |
| IS Fundamentals | ISF | ,63 | 1,204 | 6 |
| IT Consulting | ITC | ,59 | 1,121 | 8 |
| Enterprise Architecture Management | EAM | ,41 | ,939 | 10 |
| Business Process Management | BPM | ,59 | 1,278 | 9 |
| Managing Security, Compliance and Risk | MSCR | -,06 | 1,197 | 15 |
| Sustainability and Ethics | SE | -,41 | 1,543 | 17 |
| IT Governance | ITG | -,18 | 1,185 | 16 |
| Cloud Computing | CC | ,12 | 1,269 | 11 |
| Outsourcing | Out | ,06 | 1,345 | 14 |
| Virtualization | Vir | ,76 | 1,251 | 2 |
| Modeling | Mod | ,12 | 1,269 | 12 |
| Customer and Employee Satisfaction | Sat | ,06 | 1,569 | 13 |
| Enterprise Resource Planning | ERP | ,63 | 1,360 | 7 |
| Coaching | Coa | -,56 | 1,459 | 19 |
| IT Training | ITT | -,44 | 1,365 | 18 |
| Interpersonal Skills | Int | ,88 | 1,054 | 1 |
| Leadership Management | Lea | ,76 | 1,251 | 3 |
| Project Management | Proj | ,76 | ,903 | 4 |

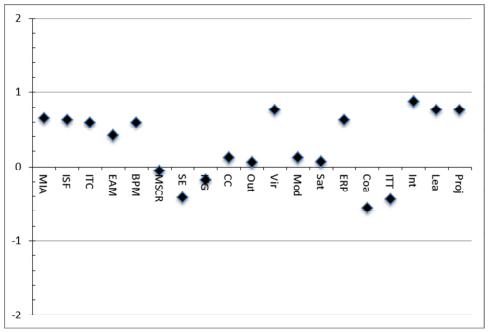


**Fig. 2.** Self-assessed Skills of the CIOs

The highest ranked skills are Interpersonal Skills (Int), Leadership Management (Lea) and Project Management (Proj) as well as the methodological and technical skills Virtualization (Vir) and Management in the Information Age (MIA). Interestingly, all personal skill modules (Int, Lea, and Proj) are among the top 4 of highest ranked skills. CIOs seem to be very confident when it comes to the assessment of their personal skills. The skills in IS Fundamentals (ISF) and Enterprise Resource Planning (ERP) are also ranked relatively high. One has to note that the standard deviation for these skills is quite low and therefore the responses have been quite similar in these cases. Within the top 10 of the highest ranked skills all modules from the framework for teaching IT management and IT consulting can be found, except Managing Security, Compliance and Risk (MSCR) and Sustainability and Ethics (SE). Interestingly, those two modules are in the top 5 list of the lowest ranked skills. Next to MSCR and SE, Coaching (Coa), IT Training (ITT), and IT Governance (ITG) are also ranked quite low. Here, CIOs need further training. Also Outsourcing (Out), Customer and Employee Satisfaction (Sat), Modeling (Mod), and Cloud Computing (CC) are ranked low. In opposite to the highest ranked skills, the standard deviations are high. Therefore, the responses have been quite different in these cases. Nevertheless, the necessity of training can be identified in these cases.

As stated before, interrelations between the skill items shall be investigated. In order to do so, correlations have been calculated (cf. Figure 3). The figure shows the correlation coefficients. The higher the value the stronger is the relationship. As rules of thumb one can say that a coefficient of .30 and above is a strong relationship. If the value is less than .10, the relationship is weak. If the algebraic sign is negative, the interpretation is that the higher a value of one variable the lower is the value of another variable. A two-tailed significance of each correlation is also calculated meaning that the hypothesis is tested for non-correlation between two variables in the population. In addition to the correlations of the 19 skill variables, also the correlation be-

tween the age of the participants and the skill items has been calculated. Using the gender or industry sector was not successful because of the amount of data. As one can see from Figure 3, the age of the participants is positively correlated between ERP, BPM, ITG, Mod, and Sat. The correlations are in each case significant at .05 levels (depicted by * in Figure 3). Therefore, one can generally say that the older the participants are, the better they evaluate their skills in these five areas. Interestingly, no personal skill item is correlated with age. Only the Proj skill item has a relatively strong relationship with the Age variable. Nevertheless, this is not significant.

| | | Age | MIA | ISF | ITC | EAM | BPM | MSCR | SE | ITG | CC | Out | Vir | Mod | Sat | Coa | ERP | ITT | Int | Lea | Proj |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Correlation Coefficient | 1,000 | | | | | | | | | | | | | | | | | | | |
| | Sig. (2-tailed) | | | | | | | | | | | | | | | | | | | | |
| MIA | Correlation Coefficient | ,059 | 1,000 | | | | | | | | | | | | | | | | | | |
| | Sig. (2-tailed) | ,781 | . | | | | | | | | | | | | | | | | | | |
| ISF | Correlation Coefficient | -,299 | ,067 | 1,000 | | | | | | | | | | | | | | | | | |
| | Sig. (2-tailed) | ,166 | ,777 | . | | | | | | | | | | | | | | | | | |
| ITC | Correlation Coefficient | ,396 | ,172 | -,039 | 1,000 | | | | | | | | | | | | | | | | |
| | Sig. (2-tailed) | ,059 | ,452 | ,866 | . | | | | | | | | | | | | | | | | |
| EAM | Correlation Coefficient | ,025 | -,345 | -,396 | -,132 | 1,000 | | | | | | | | | | | | | | | |
| | Sig. (2-tailed) | ,910 | ,152 | ,105 | ,577 | . | | | | | | | | | | | | | | | |
| BPM | Correlation Coefficient | **.505*** | -,131 | -,330 | ,221 | ,158 | 1,000 | | | | | | | | | | | | | | |
| | Sig. (2-tailed) | **,014** | ,563 | ,148 | ,320 | ,498 | . | | | | | | | | | | | | | | |
| MSCR | Correlation Coefficient | -,067 | ,393 | -,128 | -,174 | ,394 | ,167 | 1,000 | | | | | | | | | | | | | |
| | Sig. (2-tailed) | ,756 | ,090 | ,584 | ,446 | ,101 | ,457 | . | | | | | | | | | | | | | |
| SE | Correlation Coefficient | ,240 | ,114 | ,126 | ,302 | -,114 | ,300 | ,139 | 1,000 | | | | | | | | | | | | |
| | Sig. (2-tailed) | ,238 | ,608 | ,576 | ,168 | ,621 | ,163 | ,530 | . | | | | | | | | | | | | |
| ITG | Correlation Coefficient | **.424*** | ,376 | ,038 | **.504*** | ,000 | ,242 | ,259 | **.508*** | 1,000 | | | | | | | | | | | |
| | Sig. (2-tailed) | **,045** | ,105 | ,873 | **,027** | 1,000 | ,281 | ,263 | **,022** | . | | | | | | | | | | | |
| CC | Correlation Coefficient | -,122 | ,301 | ,133 | ,059 | ,268 | -,148 | ,283 | ,203 | ,291 | 1,000 | | | | | | | | | | |
| | Sig. (2-tailed) | ,557 | ,185 | ,565 | ,792 | ,256 | ,502 | ,212 | ,350 | ,200 | . | | | | | | | | | | |
| Out | Correlation Coefficient | -,030 | **.481*** | ,140 | ,150 | -,117 | -,278 | ,121 | ,248 | ,272 | ,419 | 1,000 | | | | | | | | | |
| | Sig. (2-tailed) | ,885 | **,032** | ,537 | ,499 | ,614 | ,201 | ,589 | ,249 | ,224 | ,057 | . | | | | | | | | | |
| Vir | Correlation Coefficient | ,166 | ,417 | -,178 | ,164 | ,331 | ,230 | **,739**** | ,412 | ,420 | **.500*** | **.466*** | 1,000 | | | | | | | | |
| | Sig. (2-tailed) | ,427 | ,065 | ,437 | ,462 | ,157 | ,293 | **,001** | ,056 | ,062 | **,024** | **,033** | . | | | | | | | | |
| Mod | Correlation Coefficient | **.457*** | ,012 | -,229 | ,378 | ,161 | **.635**** | ,136 | ,356 | **.537*** | -,183 | -,073 | ,202 | 1,000 | | | | | | | |
| | Sig. (2-tailed) | **,028** | ,958 | ,320 | ,092 | ,496 | **,004** | ,549 | ,102 | **,018** | ,411 | ,739 | ,360 | | | | | | | | |
| Sat | Correlation Coefficient | **.437*** | -,100 | -,360 | ,317 | ,148 | **.539*** | ,108 | **.620**** | ,281 | ,056 | ,033 | ,310 | **.473*** | 1,000 | | | | | | |
| | Sig. (2-tailed) | **,038** | ,662 | ,107 | ,158 | ,531 | **,015** | ,634 | **,004** | ,216 | ,800 | ,881 | ,161 | **,034** | . | | | | | | |
| Coa | Correlation Coefficient | ,277 | ,407 | -,158 | ,062 | ,028 | ,124 | ,301 | ,319 | ,263 | ,345 | ,371 | **.441*** | ,000 | ,436 | 1,000 | | | | | |
| | Sig. (2-tailed) | ,190 | ,076 | ,499 | ,783 | ,906 | ,578 | ,189 | ,148 | ,251 | ,124 | ,095 | **,048** | 1,000 | ,053 | . | | | | | |
| ERP | Correlation Coefficient | **.468*** | ,090 | -,417 | **.491*** | -,172 | ,250 | -,243 | ,144 | ,290 | -,244 | ,057 | ,000 | ,337 | ,185 | ,022 | 1,000 | | | | |
| | Sig. (2-tailed) | **,028** | ,697 | ,078 | **,031** | ,475 | ,264 | ,291 | ,515 | ,208 | ,280 | ,799 | 1,000 | ,136 | ,415 | ,920 | . | | | | |
| ITT | Correlation Coefficient | ,248 | ,450 | -,269 | ,201 | ,272 | ,091 | ,413 | ,300 | **.471*** | **.593**** | **.625**** | **.686**** | ,081 | ,371 | **.589**** | ,157 | 1,000 | | | |
| | Sig. (2-tailed) | ,245 | ,052 | ,255 | ,377 | ,258 | ,685 | ,073 | ,176 | **,041** | **,009** | **,005** | **,002** | ,719 | ,103 | **,008** | ,481 | . | | | |
| Int | Correlation Coefficient | ,189 | ,000 | ,269 | ,254 | -,237 | ,174 | -,372 | ,425 | ,142 | ,000 | ,212 | -,108 | ,231 | ,335 | ,114 | ,173 | ,130 | 1,000 | | |
| | Sig. (2-tailed) | ,369 | 1,000 | ,249 | ,264 | ,321 | ,436 | ,106 | ,054 | ,538 | 1,000 | ,342 | ,631 | ,306 | ,138 | ,616 | ,451 | ,571 | . | | |
| Lea | Correlation Coefficient | ,175 | ,286 | ,110 | ,433 | ,040 | ,042 | ,112 | ,412 | **.509*** | ,138 | ,301 | ,211 | ,404 | ,422 | ,414 | ,140 | ,349 | **.512*** | 1,000 | |
| | Sig. (2-tailed) | ,400 | ,205 | ,634 | ,052 | ,865 | ,848 | ,619 | ,056 | **,024** | ,531 | ,169 | ,337 | ,067 | ,058 | ,064 | ,535 | ,121 | **,022** | . | |
| Proj | Correlation Coefficient | ,367 | ,172 | ,098 | **.701**** | -,302 | ,075 | -,349 | ,193 | ,451 | -,319 | ,211 | -,088 | ,447 | ,066 | -,094 | **.543*** | ,041 | ,453 | ,442 | 1,000 |
| | Sig. (2-tailed) | ,084 | ,462 | ,677 | **,002** | ,212 | ,739 | ,133 | ,386 | ,052 | ,162 | ,348 | ,696 | ,050 | ,774 | ,683 | **,019** | ,861 | ,051 | ,051 | . |

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

**Fig. 3.** Skill Correlation Matrix

For getting a better overview of the relationships between the remaining 19 skill items, a skill correlation network diagram has been generated (cf. Figure 4). This diagram focuses on the significant relationships and shows correlations that are either significant at the .05 level (depicted by *) or at the .01 level (depicted by **). The colors depict the methodology skill items (orange), the personal skills (green) and the additional named skills (blue). First of all, one recognizes that skills in the seven methodological variables from the framework by Boehm et al. [27] have no relation-

ship with each other. Therefore, these courses seem to cover a mutually exclusive and collectively exhaustive field.

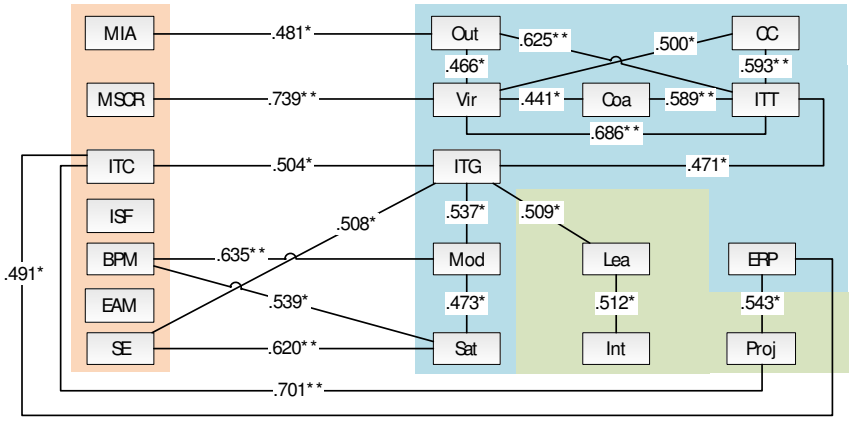


**Fig. 4.** Skill Correlation Network Diagram

Within the personal skills, the variables Lea and Int are positively correlated. The relationship leads to the supposition that CIOs with high interpersonal skills also have high leadership management skills. This can be seen as a causal relationship because one cannot set one of the skills apart from the other. The Proj variable is not correlated to the other personal skills. However, it has strong relationships with ERP and ITC. Also ERP and ITC are correlated. One might conclude that this is the classical causal relationship within an ERP implementation project and consulting activities within the company. By investigating the other methodological modules one recognizes that two modules, ISF and EAM, have no correlation with others. The reason for this should be investigated in future research. Although the relationship for example between EAM and ITG has been widely discussed in literature [39], the CIOs in our study have not yet acknowledged this link. This research-practitioner gap should be overcome in future. The MIA, BPM, MSCR, and SE module have strong relationships with the other variables. However, MIA is for example connected to outsourcing. MIA is currently only indirectly connected to skills like Vir and ITT. The MSCR module also has a strong relationship to only one other skill, namely Vir. Therefore, CIOs may not discern the links between these skills. A strong relation can be shown between BPM and Mod. As modeling skills are very often required in business process reengineering, this highly significant correlation is comprehensible. Interestingly, BPM is also correlated with Sat. CIOs may need skills especially for employee satisfaction in order to successfully implement BPM. Another strong relationship has been discovered between SE and ITG as well as Sat. Due to that fact that SE is a relatively new field this correlation has not been discovered so far.

The important skills identified in the first workshop are all highly related to each other and the modules of the framework by Boehm et al. [27]. A small sub-network is formed by Out, Vir, Coa, ITT and CC. Here, all skills have strong relationships with each other. Only Out and CC are not linked. This is very interesting because usually it

is said that cloud computing is a form of outsourcing [40]. Nevertheless, CIOs have not yet built up skills in these two areas at the same time. CC is currently only related to Vir and ITT. Though, the topic of CC is much more complex [40]. Vir and ITT are the most complex skills because they have strong relationships with several other skills: Vir is connected to MSCR, CC, Out, Coa, and ITT; ITT is linked to ITG, CC, Out, Vir, and Coa. In planning training programs for CIOs, planners have to keep this fact in mind and design programs which integrate these skills. Additionally, Out with its relation to MIA, Vir and ITT has to be covered as well. Another sub-network is formed by ITG, Mod, Sat and correlations to the respective other skills. ITG is also a very complex skill because it has strong relationships to ITC, SE, Mod, ITT, and Lea. From this list one sees the interdisciplinary approach of IT governance. Next to its relation to BPM, the skill Mod is related to Sat. This can also be explained by their correlations to the CPM kills.

# 5 Discussion

## 5.1 Answering the Research Question

The results offer some interesting insights into the working field of the CIO. CIOs have the highest skills in Interpersonal Skills, Leadership Management and Project Management as well as the methodological and technical skills Virtualization and Management in the Information Age. A backlog demand can be identified in the fields of Managing Security, Compliance and Risk, Sustainability and Ethics, Coaching, IT Training, and IT Governance. The analysis of interrelations between the skills also gives several insights. Research-practitioner gaps can be identified by the fact that CIOs have not yet recognized the connection between certain topics, for instance cloud computing and outsourcing. This gap should be overcome in future by establishing a better knowledge transfer between research and practice. Additionally, new skills in Sustainability and Ethics for example are required. As these skills are closely related to others, one has to keep this in mind when designing training programs for CIOs. It is important that CIOs build up skills in two or more areas like cloud computing and outsourcing at the same time. In general, one can learn from the correlation analysis that the CIOs' tasks are interdisciplinary and highly interrelated.

By comparing these results with the to-be profile of the CIO role (cf. Table 1), one recognizes that the skill categories of the role are much broader than the skills discussed in the workshops. Only IT governance and personnel development can be found in both. As our results show, the CIOs' skills in these areas are at least expandable. The average values of .12 (for ITG) and .06 (for Sat) should be higher in order to fulfill the required levels of the to-be profile. As the remaining skills of this study have been investigated on another level of analysis, it is difficult to compare them with those in the to-be profile.

### 5.2 Implications

From this study, several implications for theory and practice can be drawn. First, researchers should admit that practitioners work on another set of topics out of which some are even solved in scientific literature. It can be said that closer collaboration and discussion of researchers and practitioners are necessary. As Rosemann and Vessey noted, this research is a first step for their applicability checks [41]. Hence, the research-practice gap can be reduced using results of this paper.

Second, this research enhances the knowledge about interrelations of skills. With the help of the results, an in-depth investigation of this field can be started.

Third, the analysis is a know-how basis for teaching CIOs in future: Knowledge about which skills CIOs need further training and which skills are related to one another is highly valuable for doing so. The results can also be used for supervision and controlling of projects as well as training programs in practice. If for example an IT professional wants to attend a seminar on ERP systems, he might search for programs offering also project management and IT consulting skills.

Forth, this paper shows that practitioners increasingly need to be aware of technological developments and take part in training programs in order to stay up-to-date. This analysis can be a starting point for doing so.

### 5.3 Limitations

Skills of CIOs depend on company's IT strategy, size, industry, culture and more. Therefore, different requirement profiles for CIOs should be specified. For example, a CIO of a small mechanical company needs to know more about production planning, while a CIO of a large public company needs to be expert for e-government. However, the to-be profile of the CIO role is a good basis for further investigations.

Of course, this empirical analysis offers some limitations. The sample size is enough to show valuable results but the research could still benefit from more data. A comparison of CIOs in different countries around the world might be one extension. Additionally, the self-assessment could be augmented by other methods for measuring skill levels. The results of this contribution can be used to conduct surveys among a greater number of CIOs. It should also be tested if the list of 19 skill items can be extended with skills derived from the trend analysis or other contributions in literature [23], [42-43]. However, as discussions within our workshops show, we captured all important skill items.

## 6 Conclusion and Future Research

In this paper, we investigated the skill set of the CIO. With the help of the findings, the working field of the CIO can be better understood and teaching programs can be designed. After conducting a literature review, two workshops have been carried out. Within the first workshop, important skills for CIOs have been identified. Together with the framework by Boehm et al. [27], these skills have been collected in a list which also depicts the respective level of analysis. These levels ensure the compara-

bility of the skills. In a second workshop, the skill list was shown to CIOs. A questionnaire was used to enable an assessment of the skills of today's CIOs. Several interrelations have been identified.

In future, it is important that researchers and practitioners develop a common frame of reference when talking about skills and trends of IT professionals. More research is necessary for addressing knowledge transfer between CIOs and researchers as well as among CIOs. Here, for example joint workshops of CIOs and researchers could be conducted. Nevertheless, in this paper lies the foundation for doing so.

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