# The Role of Human Capital on Enhancing Organizational Information Technology Capabilities: An Alternative Approach

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**Abstract**

In a constantly changing world, the organizational IT capabilities are progressively perceived as vital enablers of superior organizational produc-tivity. Despite the often-accentuated importance of IT human assets, their exact role and connection with IT capabilities remain somewhat nebu-lous. Consequently, this research explores the specificities of IT human capital and its influence on IT capabilities, deriving insights from human capital literature and theories grounded in vision-oriented dynamic resources and capabilities. This investigation has considered responses from 246 Chief Information Officers employed in Brazilian public institutions and has utilized structural equation modelling (CB-SEM) for analysis. It has determined that IT human capital encompasses multidimensional attributes that include interpersonal competencies, technical expertise, and team members' engagement with technology. Furthermore, IT human capital is portrayed as a precursor to IT capabilities, not an intrinsic element, as commonly proposed in the scholarly domain. The research proposes a pragmatic, empirically validated approach to gauge and evaluate the impact of IT human resources. It also advocates potential strategies for organizations to source and cultivate IT human capital ready to con-front the perpetual dynamism of today's environments.

**Keywords:** IT human capital; IT capabilities; structural equation modelling; Public sector

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## 1. Introduction

Scholarly discourse on information technology (IT) increasingly suggests that IT capabilities of organizations, as opposed to direct expenditure on IT resources, render a more favorable impact on performance (Mata, Fuerst, & Barney, 1995; Powell & Dent-Micallef, 1997; Ray, Muhanna, & Barney, 2005; Stoel & Muhanna, 2009; Stratopoulos & Dehning, 2000). IT capabilities embody an organization's capacity to mobilize, merge, and deploy IT resources to satisfy their business processes' demands (Liu, Huang, Wei, & Huang, 2015). IT capabilities encapsulate an intricate amalgamation of IT-related resources, expertise, and knowledge, employed across business procedures (Stoel & Muhanna, 2009).

Numerous investigations underscore the importance of IT human assets—such as the technical and managerial proficiencies of the IT cadre—to the organizational IT capabilities. These human resources are often identified as key contributors to IT organizational capabilities based on their aptitude and acumen (Bharadwaj, 2000; Chen & Tsou, 2012; Park, Im, & Kim, 2011). This study, however, delineates and validates an alternative methodology to operationalize IT human capital, delineating its association with organizational IT capabilities, framed within the realm of human capital theories and dynamic capabilities. This innovative approach allows for a more precise demarcation of human capital's role in the IT capabilities of organizations. Even though the correlation between IT capabilities and IT human resources has been thoroughly investigated (Kim et al., 2011; Lu & Ramamurthy, 2011; Chen & Tsou, 2012; Kmieciak et al., 2012; Wang et al., 2014), the methodology suggested in this study is scarcely seen in current literature, thus generating a lacuna in scientific understanding that this study seeks to fill.

The purpose of this investigation is to introduce and test a theoretical model for the operationalization of IT human capital, examining its influence on an organization's IT capabilities. To accomplish this, the study utilized covariance-based structural equation modeling (CB-SEM) and confirmatory factor analysis to scrutinize data compiled from 246 IT managers across diverse Brazilian public organizations of varying size and industry. Furthermore, this study probed and quantified the effect of differences related to the size and range of organizations on the constituents of IT capabilities and IT human capital. It is crucial to consider such variations as organizations can display substantial disparities in their sizes and operational sectors. This study's method is distinct, as it emphasizes the examination of the role of IT human capital independent of the IT capabilities construct—an oversight in existing literature.

This research carries both theoretical and pragmatic implications. From a theoretical angle, the results could serve as a reference for future studies conducted in varied social, structural, economic, and geographical contexts. Moreover, the article's contribution to operationalizing the IT human capital concept as a standalone construct can offer subsequent researchers an empirically validated method to measure and assess the impact of this concept on various facets of IT research within organizations. From a practical perspective, the study furnishes insights for organizations to recruit IT human resources more

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effectively that are well-equipped to adapt to unceasingly evolving environments, consequently forging IT organizational capabilities. The research results provide practitioners with an enhanced understanding of human capital's role in enhancing IT capabilities, potentially leading to improved organizational performance.

## 2. Literature Review

### 2.1. IT Human Capital

Human capital encapsulates the array of productive capabilities inherent in individuals, inclusive of their knowledge, attitudes, and skills that yield superior outcomes (Baptiste, 2001; Becker, 1962; Blaug, 1976). The genesis of this concept is rooted in the seminal works of Schultz and Becker in the 1960s, which led to the formulation of human capital theory. The underpinning tenets of this theory assert that individuals receive education, the principal effect of which is the amplification of skills and knowledge, driven by a philosophy of investing in human beings and fostering human capital (Cunha, Cornachione Junior, & Martins, 2010). The advent of human capital theory prompted the organizational sphere to acknowledge the value of the human element due to its capacity to produce services (Blaug, 1976; Cunha et al., 2010).

As elucidated by Kucharčíková (2011), human capital can be envisioned as an amalgamation of intellect, human skills, and experience that imparts a distinct character to the organization, in other words, they epitomize the human components of the organization, endowed with the capability to learn, innovate, transform, and infuse creativity that can guarantee superior results and the enduring survival of organizations. The literature acknowledges the critical importance of human capital for organizations (Liu, 2014), for instance, as a springboard for innovation (Subramaniam & Youndt, 2005), organizational performance (Hitt et al., 2001; Reed et al., 2006), and a wellspring of competitive advantage (Barney & Wright, 1998; Coff & Kryscynski, 2011; Ployhart & Moliterno, 2011).

Human capital is traditionally distinguished in the literature as either general or specific (van Teeffelen & Uhlaner, 2013). General human capital, such as expansive professional experience, can be transported across organizations, while specific human capital, such as professional experience accrued within a specific organization, is only applicable within that organization and not readily transferable (Becker, 1962; Wang, Chou, Lee, & Lai, 2014). For Hatch and Dyer (2004), human capital is an intangible and socially complex concept. In a similar vein, Ployhart and Moliterno (2011) propose that human capital ought to be perceived as a collective resource, as employees generally collaborate in the organizational context. However, Cunha et al. (2010) caution that a distinguishing attribute of human capital from physical capital is its inherent belonging to the individual, rendering the source of funding for its development of less consequence. On the other hand, akin to physical capital, human capital can become outdated and necessitates ongoing maintenance.

In line with existing research, the specific importance of human capital relating to the information technology (IT) teams of organizations has been emphasized in the literature (Wang, Chou, Lee, & Lai, 2014). Ravichandran and Lertwongsatien (2005) highlight that the human capital of IT departments is a crucial input for the cultivation of organizational capabilities. Specifically, the human capital of IT departments comprises technical and business acumen of IT personnel, and their explicit knowledge of the organization, inclusive of its culture and routines. Park, Im, and Kim (2011) argue that human IT capabilities, incorporating the skills requisite for managing organizations' IT resources, include technology management, business, interpersonal, and management skills, in addition to technical proficiency. In their perspective, viewing IT human capital through the theoretical lens of resource-based view, it can be considered a rare, valuable, and non-replicable resource.

Correspondingly, Hulland, Wade, and Antia (2007) posit that the technical prowess of IT personnel is not confined to their technical knowledge but extends to their capacity to effectively apply, manage, and utilize their knowledge. They further suggest that despite the high turnover rate of IT staff, certain intangible IT skills such as corporate-level knowledge assets and technology integration skills are embedded within the organization, making them more difficult to acquire, capitalize, replicate, or replace.

### 2.2. IT Organizational Capabilities

The notion of organizational capabilities refers to the aptitudes that enable an organization to amass, amalgamate, and utilize its valuable, rare, and hard-to-imitate resources to cultivate unique competencies (Teece, Pisano, & Shuen, 1997). Organizational capabilities and resources underpin the strategic direction and serve as the primary generators of organizational outcomes (Grant, 1991). However, a fundamental demarcation exists between a resource and an organizational capability. Makadok (2001) expounds that a resource is a visible asset, not necessarily tangible, that can be independently assessed and negotiated, while a capability is invisible and thus, innately intangible.

Building upon this differentiation, Grant (1991) identifies resources as the fundamental inputs that drive organizational processes. Ranging from tangible assets like equipment and capital to intangible assets such as employee skills, patents, and brands, these resources contribute to the breadth of organizational capabilities. However, the smooth functioning of an organization hinges on the synergistic collaboration and coordination of these diverse resources, bringing us to the definition of capability as the capacity of a resource assemblage to perform a coordinated task or activity.

Delving deeper into the connection between resources and capabilities, Makadok (2001) elucidates two predominant theoretical streams within the strategy domain. The first, the resource-based view, springs from Ricardo's propositions (Ricardo, 1917) and emphasizes the pivotal role of resource selection and deployment in organizational value creation. The second stream, the dynamic capabilities perspective, draws inspiration from Schumpeter (1950) and underscores the continuous development of organizational capabilities rooted in available resources, achieved through intricate processes and resource deployment by managers and workers (Amit & Schoemaker, 1993).

Transitioning to the realm of IT, the concept of IT capabilities refers to an organization's aptitude to mobilize, integrate, and leverage IT resources that are congruent with business process demands (Liu et al., 2015). Stoel and Muhanna (2009) present IT capabilities as a sophisticated configuration of IT-related resources, skills, and knowledge operationalized through organizational processes. Research on operationalizing IT capability, such as that of Bharadwaj (2000) and Kim, Shin, Kim, and Lee (2011), have shed light on various facets of IT capabilities ranging from IT infrastructure and human resources to intangible IT resources, IT specialization, infrastructure flexibility, and management capability.

Progressing this discourse, Chen and Tsou (2012) conceive IT capabilities as a second-order factor with four sub-dimensions. Meanwhile, Kmieciak, Michna, and Meczynska (2012) propose three dimensions of IT capabilities, focusing on the application of IT in support of business areas. These perspectives underscore the interplay between various elements of IT capabilities, whether it's the suite of applications in IT infrastructure, the integration of IT and business strategies, or the facilitation of internal communication.

Finally, taking a comprehensive view, Chen et al. (2015) proposed that organizational IT capabilities be operationalized as a second-order construct composed of four dimensions: IT infrastructure flexibility, IT integration, IT and business alignment, and IT management. The authors suggest that the flexibility of the IT infrastructure pertains to the degree to which an organization's IT infrastructure can be scaled, modularized, integrated with legacy systems, and applied to various business applications. IT integration concerns how an organization connects its IT with that of its business partners. IT management refers to the company's capacity to implement IT-related activities effectively. Lastly, IT business alignment denotes the extent to which IT and business operations share common objectives and maintain a harmonious relationship.

**2.3. Relationship between IT Human Capital and IT Capabilities**

The expansive literature on IT human capital and IT capabilities reveals notable diversity, indicative of the intricate nature of these concepts and their interactions. Despite the vast array of studies within this field, a consensus on the operationalization of the IT capabilities construct remains elusive, thereby creating a fertile ground for further exploration.

Focusing on the facet of IT human capital, the literature reflects disparate approaches. A body of research has chosen to directly integrate the technical and managerial skills of IT personnel into the framework of organizational IT capabilities (Chen & Tsou, 2012; Kim et al., 2011; Kmieciak et al., 2012). This approach perceives IT human capital as an intrinsic component of IT capabilities. Contrastingly, another segment of studies refrains from defining IT human resources as an explicit constituent of IT capabilities (Lu & Ramamurthy, 2011; Wang et al., 2014). The latter viewpoint treats IT human capital as a distinct entity that fuels IT capabilities. In the context of this study, we align with the latter perspective, considering IT human capital as a separate element that contributes to IT capabilities rather than being a constituent part of it. We assert that IT human capital, while vital for the development of IT capabilities, maintains its independent existence and character.

Grounded in the theoretical perspective of dynamic capabilities, it is essential to perceive IT human resources as valuable assets. As such, akin to other organizational resources like equipment, capital, patents, and brands, IT human capital emerges as a pivotal element for developing organizational IT capabilities in a synergistic manner (Amit & Schoemaker, 1993; Grant, 1991; Makadok, 2001).

In the lens of the human capital theory, IT department's human capital is recognized as an indispensable input for developing organizational capabilities (Ravichandran & Lertwongsatien, 2005). It is understood to encompass 'hard skills' or technical abilities needed for programming, analysing, and designing systems, networks, and data storage. Concurrently, 'soft skills' or interpersonal skills entail abilities needed for managing information systems functions, interacting with users, and executing project management and leadership tasks. Moreover, the relationship between the IT team and technology, capturing how effectively IT staff manage IT functions and engage in self-learning processes related to IT, forms a vital part of the IT human capital (Byrd & Turner, 2001; Lee, Trauth, & Farwell, 1995). Thus, based on the above arguments and the complexity of the relationship between IT human capital and IT capabilities, this study proposes a distinction between these two constructs, recognizing their mutual influence yet separate identities. This approach allows us to propose four hypotheses to be examined in the present study.

Firstly, the capacity to engage effectively with others, navigate through social complexities in the workplace, and stimulate collaboration within teams constitutes an important element of IT human capital (Wilkins et al, 2016). Interpersonal skills transcend the realm of merely being desirable traits and emerge as vital for effective team functioning and pursuit of shared objectives (Kanawattanachai & Yoo, 2002). The IT team's interpersonal capacity, characterized by effective transmission of technical information, adept conflict management, and the fostering of a collaborative environment, is a crucial facet of the broader construct of IT human capital (Zang, 2012; Misra & Khurana, 2017). Consequently, the interpersonal ability significantly amplifies the value inherent in an organization's IT human capital. Thus, with this understanding, we propose the following hypothesis:

**$H_1$**. The interpersonal ability of the IT team is a factor underlying the organization's IT Human Capital.

Secondly, technical skill encompasses the proficiency and expertise related to distinct tasks, technologies, and processes that the IT personnel command (Huang, 2010; Bolívar-Ramos et al., 2013). The acquisition of these skills facilitates problem resolution, troubleshooting, and the incorporation of novel technologies, all of which culminate in the effective and efficient operations within an organization (Lee et al., 1995; Okoye et al., 2020; Osiurak et al, 2021). Consequently, the technical skills of the IT team make a significant contribution to an organization's IT human capital. In this regard, we propose the subsequent hypothesis:

**$H_2$**. The technical skill of the IT team is a factor underlying the organization's IT Human Capital.

Thirdly, the relationship IT professionals maintain with technology signifies their adaptability to novel technologies, comprehension of, and capacity to manage the ramifications of technological shifts, and facilitating the incorporation and integration of emerging technologies into extant systems (Byrd & Turner, 2001). This dynamic interaction necessitates an understanding of technological trends and an appraisal of the impact exerted by technology on the organization's business processes and strategy. This preparedness to engage with technology, married with the ability to oversee IT functions and pursue autonomous learning, significantly enhances an organization's IT human capital (Devaraj & Kohli, 2003). Thus, in view of this, we introduce the subsequent hypothesis:

**$H_3$**. The relationship of IT professionals with technology is a factor underlying the organization's IT Human Capital.

Lastly, IT human capital, manifesting its multifaceted components of interpersonal capability, technical expertise, and dynamic relationship with technology, assumes a paramount role in sculpting an organization's IT capabilities. The varied skills and proficiency of IT personnel, coupled with their adaptability and collaborative work ethic, can notably amplify an organization's capacity to manage and leverage IT resources (Ravichandran & Lertwongsatien, 2005). As posited by the resource-based view, human capital operates as a strategic resource, contributing significantly to the formulation of unique organizational competencies (Barney & Wright, 1991). From the vantage point of dynamic capabilities, IT human capital serves as the bedrock upon which capabilities are constructed that enable an organization to adapt to fluctuating environments and retain a competitive edge (Teece et al., 1997). Therefore, an affirmative correlation exists between IT human capital and the IT capabilities of organizations. Hence, we put forward the final hypothesis of this study:

**$H_4$**. The IT Human Capital is positively associated with the IT Capabilities of organizations.

## 3. Methodology

This research is a descriptive and quantitative study that sourced primary data through a cross-sectional survey, executed in August 2019. The survey targeted a sample of 798 senior IT managers within the public sector, occupying the role of CIO or its equivalent. These professionals were engaged across the three government branches in Brazil - Executive, Legislative, and Judiciary - as well as at the Federal, State, and Municipal levels. As is customary in IT literature (Chen, Wang, Nevo, Benitez-Amado, & Kou, 2015; Kim et al., 2011; Liang, Wang, Xue, & Ge, 2017; Wang et al., 2014), the primary respondent for this research was determined to be these managers. Each manager was individually contacted via email or phone, with the survey questionnaire disseminated through email.

Building on the approach employed by Wang et al. (2014) to quantify IT human capital, which includes technical and interpersonal skills and the interaction between the IT team and technology, this paper pioneers a fresh perspective on the interplay between IT human capital and IT capabilities. The distinction between IT human capital, being an organizational resource, and IT capabilities necessitates their independent operationalization and measurement.

The survey instrument consisted of two principal sections. The first section was designed to collect characterizing data about the sample, while the second section was equipped with items to measure the constructs under study. IT capabilities were segmented into five factors - IT flexibility, IT integration, alignment of IT and business, IT management, and reconfiguration capability. These factors were adapted from the scale devised by Chen et al. (2015) and enhanced by the inclusion of the reconfiguration capability dimension recommended by Oliveira et al. (2016). As for IT human capital, the study adopted the tripartite division proposed by Wang et al. (2014), encompassing hard skills, soft skills, and the IT team's relationship with technology.

Before the deployment of the questionnaire, the research instrument underwent a rigorous content evaluation involving three seasoned researchers specializing in information systems, alongside five IT managers from public agencies who aptly represented the research's target demographic. Following the omission and amendment of certain questionnaire items, a pre-test phase was initiated involving 21 additional public IT managers, who did not report any issues with the comprehension of the questions or any other concerns. Preliminary data analysis did not flag any challenges in model specification. The Google Forms platform was utilized to administer the questionnaire, which, after three weeks of data collection, generated 278 complete responses, constituting a response rate of 34.8%. The final versions of the scales utilized are presented in Appendix 1.

Data analysis was conducted using IBM SPSS and IBM AMOS, both version 27. The covariance-based structural equation modelling (CB-SEM) using confirmatory factor analysis (CFA) in a two-step strategy as outlined by Anderson and Gerbing (1988) was the chosen method for analysis. The first step involved establishing the measurement model, followed by the identification of potential multivariate outliers by calculating the Mahalanobis squared distance ($D^2$) (Marôco, 2014). A conservative approach led to the exclusion of 32 responses with p1 and p2 values exceeding 0.001, thereby yielding a final sample size of 246 observations. Subsequent normality checks of variables were performed using skewness coefficients (Sk) and kurtosis (Ku) (Marôco, 2014), revealing no violations of normal distribution, as indicated by $|Sk|<2$ and $|Ku|<7$ (Marôco, 2014).

Upon completion of the data processing phase, the CFA measurement model was adjusted. The first step involved assessing the factor loadings without encountering any issues (Hair et al., 2009). Following this, the Modification Indices provided by AMOS were reviewed, with values exceeding 11 being interpreted as indicative of local adjustment issues, leading to the correlation of theoretically justified measurement errors (Marôco, 2014). The structural model was then specified in accordance with the research hypotheses. Finally, we examined the potential differences between groups based on sample characteristics, such as organization size and sphere of action, by

specifying MIMIC models (Multiple Imputation and Multiple Causes) using SEM, as proposed by Joreskog and Goldberger (1975). This method offers an efficient and robust mechanism to identify group differences within a structural model (Marôco, 2014).

## 4. Results and Discussion

The data analysis commenced with a characterization of the sample, and a summary thereof is presented in Tables 1 and 2.

**Table 1**. Characterization of organizations

| Size | Frequency | Percentage |
|---|---|---|
| up to 100 workers | 26 | 10.6 |
| between 101 and 500 workers | 48 | 19.5 |
| between 501 and 1,500 workers | 73 | 29.7 |
| between 1,501 and 5,000 workers | 66 | 26.8 |
| between 5,001 a 10,000 workers | 19 | 7.7 |
| over 10,000 workers | 14 | 5.7 |
| **Level** | | |
| municipal organizations | 20 | 8.1 |
| state organizations | 48 | 19.5 |
| federal organizations | 178 | 72.4 |
| **Field** | | |
| justice | 51 | 20.7 |
| education | 54 | 22.0 |
| health | 24 | 9.8 |
| research and education | 15 | 6.1 |
| public security | 6 | 2.4 |
| banking and economic | 7 | 2.8 |
| military | 5 | 2.0 |
| transportation | 11 | 4.5 |
| municipal government | 20 | 8.1 |
| others | 53 | 21.5 |

Source: Own

**Table 2.** Characterization of key respondents

| | Frequency | Percentage |
|---|---|---|
| Formal Education | | |
| high School/Technical/Other | 7 | 2.8 |
| university level | 41 | 16.7 |
| specialization course | 106 | 43.1 |
| master's or Doctorate | 92 | 37.4 |
| Gender | | |
| women | 24 | 9.8 |
| men | 222 | 90.2 |
| Professional experience | | |
| up to 2 years | 9 | 3.7 |
| between 2 and 5 years | 33 | 13.4 |
| between 6 and 10 years | 46 | 18.7 |
| between 11 and 15 years | 46 | 18.7 |
| between 16 and 20 years | 27 | 11.0 |
| 21 years or older | 85 | 34.6 |
| Age | | |
| up to 29 years | 6 | 2.4 |
| between 30 and 39 years | 80 | 32.5 |
| between 40 and 49 years | 98 | 39.8 |
| between 50 and 59 years | 54 | 22.0 |
| 60 years or older | 8 | 3.3 |

Source: Own

The respondent sample, comprised of 246 IT managers, is characteristically dominated by males, who constitute 90.2% of the pool. The age bracket most heavily represented falls within the range of 40 to 49 years, accounting for 39.8% of the total sample. Over one-third of the respondents (34.6%) bring more than two decades of professional experience to their roles. Post-graduate degrees are held by a substantial segment of the sample, amounting to 43.1%. The majority of participants hail from medium-sized organizations, characterized by a workforce ranging from 500 to 1,500 individuals, accounting for 29.7% of the respondents. These organizations predominantly operate within the federal sector of Brazilian public administration (72.4%), with the most represented industries being education (22%) and justice (20.7%). While there is a noticeable inclination towards federal organizations with national operations, as opposed to those functioning on a local or regional level, there are no discernible biases or trends that could potentially undermine the representativeness of the data. As such, the sample was deemed appropriately suited to the aims of the research.

Subsequently, the researchers engaged in the specification of the structural measurement model, an initial component of confirmatory factor analysis as defined by Anderson & Gerbing (1988). The outcomes of this analysis are outlined as follows: $\chi^2 = 1687.356$; $\chi^2/df = 2.649$; Comparative Fit Index (CFI) = 0.858; Tucker-Lewis Index (TLI) = 0.844; Goodness-of-Fit Index (GFI) = 0.747; Root Mean Square Error of Approximation (RMSEA) = 0.079; Standardized Root Mean Square Residual (SRMR) = 0.0684. However, these values did not meet the necessary thresholds for additional examination, according to the standards delineated by Hair et al. (2009). Nonetheless, drawing upon Morôco's directives (Marôco, 2014), the researchers undertook the correlation of the errors of observed variables that pertained to the same construct. The correlation process was steered by the Modification Indices produced by AMOS (MI > 11). In doing so, the researchers connected the errors of the variables ALI4 with ALI5 (Alignment), MAN1 with MAN2 (Management), REC3 with REC4 (Reconfiguration), SSK1 with SSK2, SSK2 with SSK3 (Soft Skills), and RET2 with RET3 (Relation with Technology). As a result, there was a marked enhancement in the goodness of fit indicators, which were deemed appropriate: $\chi^2 = 1211.33$; P-value = 0.000; $\chi^2/df = 1.923$; CFI = 0.918; TLI = 0.909; GFI = 0.802; RMSEA = 0061; SRMR = 0.0750. The non-significant P-value and the GFI indicator, which fell below 0.9, can be justified by the quantity of variables present in the model and the sample size (Marôco, 2014), and do not inherently indicate an issue with the model fit.

Considering these favourable outcomes regarding the goodness of fit indicators, the study proceeded to assess the convergent and discriminant validity of the constructs. To accomplish this, the reliability values of the constructs were ascertained using the composite reliability (CR) index and the average variance extracted (AVE). The results obtained were deemed satisfactory. A comprehensive report of these results is presented in Table 3, alongside the acceptance criteria for each test, following the guidelines proposed by Hair et al. (2009).

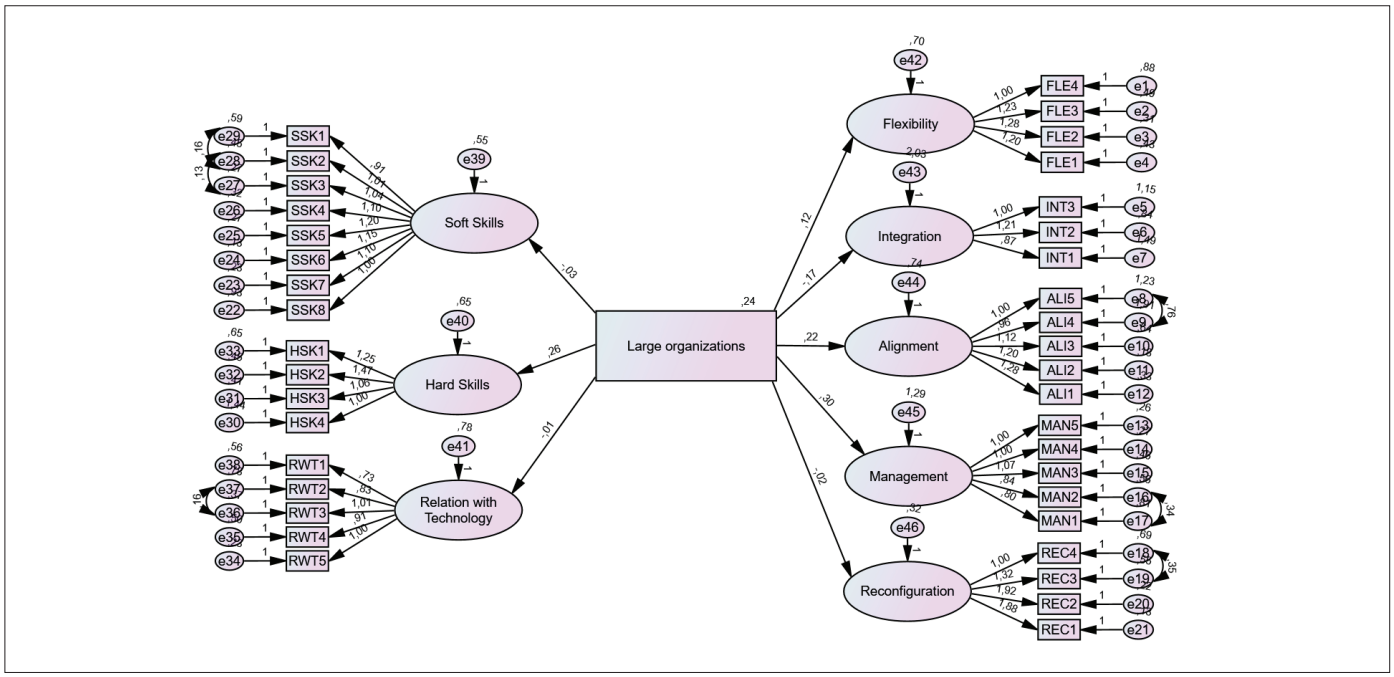
**Table 3.** Statistical significance of effects

| CONSTRUCT | REABILITY | CONVERGENT VALIDITY | DISCRIMINANT VALIDITY | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CR >=0.7 | AVE >= 0.5 | AVE > $r^2$ | | | | | | | |
| | CR | AVE | $r^2$ | | | | | | | |
| | | | FLE | INT | ALI | MAN | REC | SSK | RWT | HSK |
| Flexibility (FLE) | 0.884 | 0.657 | | | | | | | | |
| Intagration (INT) | 0.843 | 0.643 | 0.285 | | | | | | | |
| Alignment (ALI) | 0.870 | 0.582 | 0.199 | 0.049 | | | | | | |
| Managem. (MAN) | 0.926 | 0.716 | 0.339 | 0.222 | 0.286 | | | | | |
| Reconfigur.(REC) | 0.879 | 0.651 | 0.228 | 0.052 | 0.186 | 0.262 | | | | |
| Soft skills (SSK) | 0.933 | 0.640 | 0.147 | 0.045 | 0.176 | 0.158 | 0.308 | | | |
| Relat. Tech. (RWT) | 0.847 | 0.584 | 0.160 | 0.020 | 0.276 | 0.180 | 0.267 | 0.540 | | |
| Hard skills (HSK) | 0.872 | 0.578 | 0.319 | 0.073 | 0.215 | 0.264 | 0.307 | 0.501 | 0.398 | |

Source: Own

The subsequent phase of the analysis involved an initial evaluation to discern potential disparities between distinct organization clusters, stratified by their 'size' and 'sphere of action', regarding each of the seven latent variables assessed within the study. This comparative analysis was implemented between a cohort of large-scale organizations and an assembly of small to medium-sized entities. The outcomes of this comparative assessment are illustrated in Figure 1 and encapsulated in Table 4.

**Figure 1.** MIMIC model for large organizations




Source: Own

**Table 4.** Statistical significance of the effects for the large organizations group

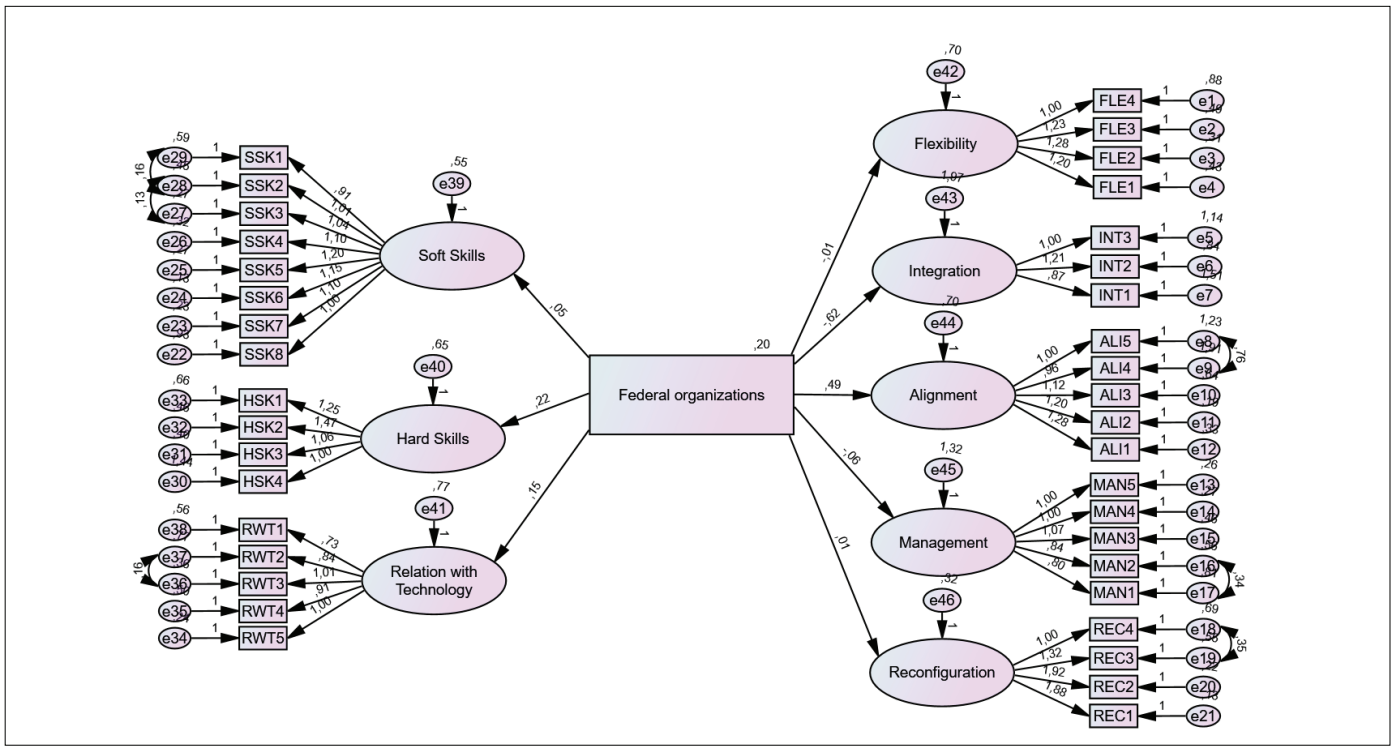
| Relations between constructs | | | Estimates | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Soft Skills | <--- | Large organizations | -0.026 | 0.100 | -0.260 | 0.795 |
| Hard Skills | <--- | Large organizations | 0.259 | 0.115 | 2.246 | 0.025 |
| Relation with Technology | <--- | Large organizations | -0.015 | 0.123 | -0.121 | 0.904 |
| Flexibility | <--- | Large organizations | 0.123 | 0.115 | 1.062 | 0.288 |
| Integration | <--- | Large organizations | -0.171 | 0.201 | -0.851 | 0.395 |
| Alignment | <--- | Large organizations | 0.222 | 0.118 | 1.877 | 0.060 |
| Management | <--- | Large organizations | 0.304 | 0.153 | 1.980 | 0.048 |
| Reconfiguration | <--- | Large organizations | -0.021 | 0.076 | -0.269 | 0.788 |

Source: Own

Within the context of IT capabilities, a lack of statistically significant disparities was noted across the dimensions of flexibility, integration, alignment, and reconfiguration when comparing organization clusters distinguished by 'size' and 'sphere of action'. Nevertheless, larger establishments were discerned to possess marginally superior IT management capacity. Additionally, the study inferred that IT professionals within larger institutions demonstrated a heightened degree of technical proficiency. In stark contrast, dimensions encapsulating interpersonal skills and the relationship with technology did not demonstrate any significant variance. These findings may be potentially attributed to the fact that larger organizations tend to allocate greater resources towards IT investments, inclusive of technical training, and offer more competitive remuneration to their IT managers. This, in turn, attracts candidates bearing superior educational credentials and experience.

On the other hand, Figure 2 and Table 5 delineate the results derived from the comparative analysis conducted between two distinct categories of organizations. The first category comprises establishments aligned with the Brazilian federal public administration, with a nationwide operational ambit. The second category includes entities operating on a local scale, at either the state or municipal level.

**Figure 2.** Statistical significance of the effects for the federal organizations group




Source: Own

**Table 5.** Statistical significance of the effects for the federal organizations group

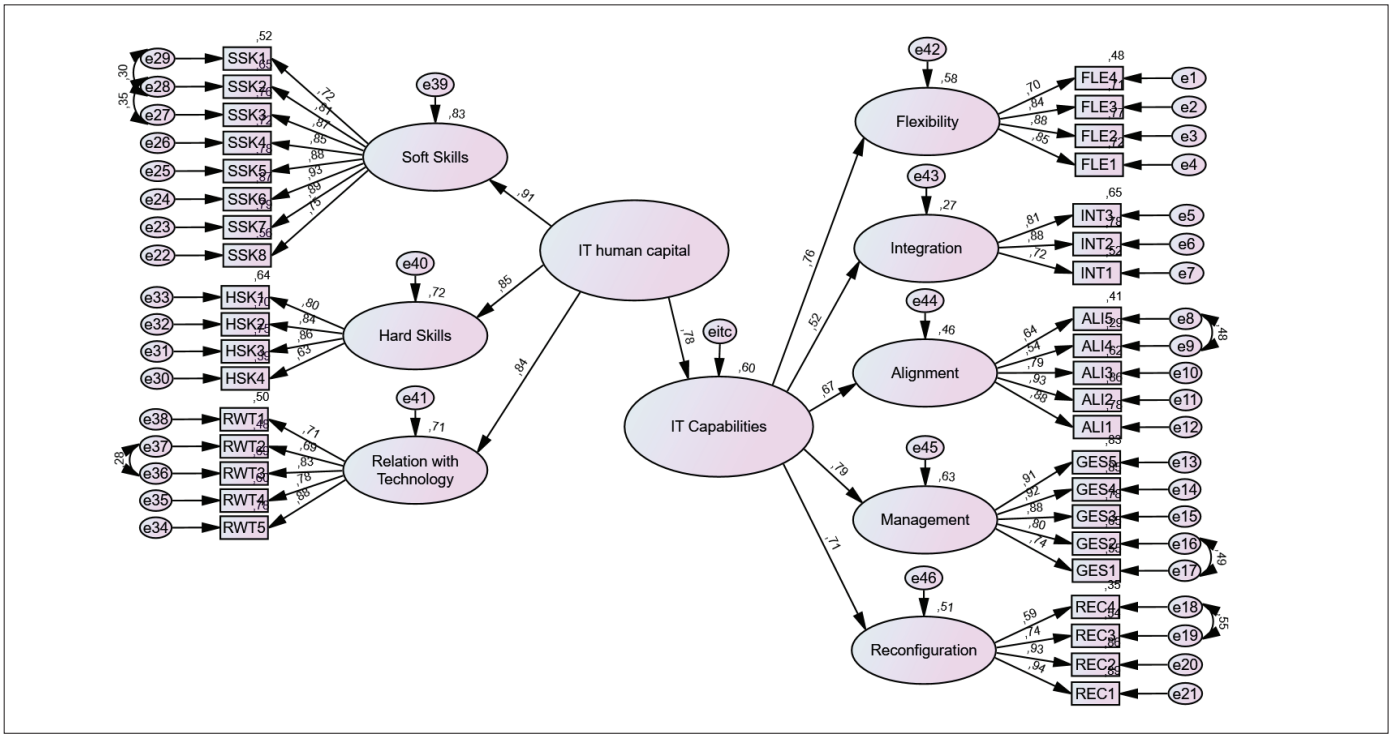
| Relations between constructs | | | Estimates | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Soft Skills | <--- | Federal organizations | 0,045 | 0,109 | 0,416 | 0,677 |
| Hard Skills | <--- | Federal organizations | 0,155 | 0,134 | 1,157 | 0,247 |
| Relation with Technology | <--- | Federal organizations | 0,223 | 0,125 | 1,78 | 0,075 |
| Flexibility | <--- | Federal organizations | -0,009 | 0,126 | -0,072 | 0,942 |
| Integration | <--- | Federal organizations | -0,616 | 0,219 | -2,821 | 0,005 |
| Alignment | <--- | Federal organizations | 0,489 | 0,132 | 3,715 | *** |
| Management | <--- | Federal organizations | -0,06 | 0,169 | -0,355 | 0,723 |
| Reconfiguration | <--- | Federal organizations | 0,007 | 0,084 | 0,088 | 0,93 |

Source: Own

In this context, there were discernible divergences between the organizational groups in relation to the factors of integration and alignment. The analysis concretely revealed that federal organizations manifested a less pronounced degree of IT integration. This infers a relatively subdued ability to identify and incorporate changes and opportunities from the external environment into their internal processes. In contrast, federal organizations displayed a higher competency to formulate an IT strategy that is in alignment with the overarching organizational strategy and contributes to the formulation and implementation of innovative objectives. No remarkable differences were observed regarding the remaining IT capability factors or within the factors pertaining to IT human capital.

Following this, the study undertook the specification of the structural model to facilitate the progression of the hypotheses. The model resulting from this exercise is detailed comprehensively in Figure 3.

**Figure 3.** Structural model




Source: Own

In consequence, the postulated hypotheses H1, H2, and H3 of the current study were effectively retrieved and corroborated. This research proposed that IT human capital could be conceptualized as a second-order construct, which encapsulates the soft skills dimensions of the IT team (H1), the technical abilities of the IT staff (H2), and the relationship of IT professionals with technology (H3). The discoveries were in alignment with the work of Wang et al. (2014), and confirmed all three original propositions of the current research, as all analysed effects were deemed to bear statistical significance. A comprehensive delineation of the results is presented in Table 6.

**Table 6.** Statistical significance of the effects on IT human capital

| Relations between constructs | | | Estimates | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Soft Skills | <--- | IT Human Capital | 0.642 | 0.069 | 9.301 | *** |
| Hard Skills | <--- | IT Human Capital | 0.722 | 0.086 | 8.42 | *** |
| Relation with Technology | <--- | IT Human Capital | 0.713 | 0.059 | 12.172 | *** |

*** p<0.001 Source: Own

The outcomes of this study affirm the feasibility of the suggested alternative model for operationalizing Information Technology (IT) human capital in organizations. Specifically, the findings illustrate that IT human capital can be efficiently structured and measured as a higher-order latent construct, encompassing three interrelated factors: technical abilities (hard skills), interpersonal competencies (soft skills), and relationship with IT. These conclusions align with the results reported by Wang et al. (2014). Notably, the investigation emphasizes the necessity of fostering both technical and interpersonal skills among IT professionals, as solely technical proficiency may prove inadequate in navigating the intricate and dynamic reality of the professional world. Instead, interpersonal skills may enable effective collaboration between IT and business personnel, resulting in a more successful implementation of IT solutions and enhanced alignment with overarching business goals.

Concurrently, apart from managerial responsibilities in this matter, IT professionals themselves should adopt a proactive approach towards updating their requisite technical knowledge. This attentiveness is particularly crucial given the persistent risk of professional obsolescence for IT personnel. Research posits that the lifespan of an IT professional's technical expertise is less than two years (Joseph, Koh, & Foo, 2010), implying that the human capital of IT professionals risks rapid depreciation (Tsai, Compeau, & Haggerty, 2007). Within this context and considering the assumptions of the resource-based view, it is recommended that organizations and specifically IT managers adopt strategies to hire and retain IT professionals who possess not only technical expertise but also exhibit interpersonal skills and a proactive stance towards continually acquiring and updating their technological knowledge. Hence, recruitment procedures must incorporate these selection criteria.

The fourth hypothesis of the current study (H4) posited a positive correlation between IT human capital and the IT capabilities of organizations. The constructed structural model explained 78% of the variance in the IT capability construct through IT human capital, thus substantiating the hypothesized correlation. These findings align with the insights proposed by Ravichandran and Lertwongsatien (2005), who argue that the human capital of IT departments is a crucial ingredient for the cultivation of organizational capabilities. A detailed account of the results is provided in Table 7.

**Table 7.** Statistical significance of the effects of IT human capital on IT capabilities

| Relations between constructs | | | Estimates | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| IT Capabilities | <--- | IT Human Capital | 0.524 | 0.070 | 7.475 | *** |

*** p<0.001 Source: Own

The necessity of equipping personnel with robust human capital, encompassing technical abilities (hard skills) and problem-solving capacities to achieve enhanced performance, is reaffirmed. Youndt et al. (1996) argue that intangible tasks, such as problem resolution, coordination, and decision-making, constitute a significant share of daily organizational activities, especially in environments characterized by uncertainty. Wang et al. (2014) also suggest that technological and strategic transformations can elevate organizational productivity, although they necessitate a more diverse skill set and superior average workforce capabilities. Consequently, it is incumbent upon organizations to ensure that their IT staff possesses an appropriate and extensive range of skills. It is recommended that ongoing training initiatives, encompassing technical elements, interpersonal relationships, and self-regulated learning behaviors, are provided for IT professionals.

In light of the principles of dynamic capabilities, it is paramount for organizations and IT managers to prioritize the cultivation of IT human resource skills with the aim of developing IT capabilities that bolster superior organizational performance. This underlines the critical role of internal IT capability building, as opposed to relying solely on direct investments in IT resources. This viewpoint aligns with earlier research conducted by Mata, Fuerst, and Barney (1995), Powell and Dent-Micallef (1997), Ray, Muhanna, and Barney (2005), Stoel and Muhanna (2009), and Stratopoulos and Dehning (2000).

## 5. Conclusions

This study proffered an alternative proposition for operationalizing Information Technology (IT) human capital and examined the interplay between human capital and IT capabilities within organizations. The current research posits that IT human capital, as a distinct organizational resource, warrants separate examination from the IT capabilities construct, rather than being treated merely as a facet of these capabilities. Employing literature from the domains of information systems and human capital and grounded in the theoretical framework of resource-based view and dynamic capabilities, data was gathered from IT managers in the Brazilian public sector. Specifically, the research devised and tested a novel theoretical model to operationalize an organization's IT human capital, incorporating hard skills,

soft skills, and the team's interaction with technology. Moreover, the study evaluated the impact of human capital on IT capabilities. The results corroborated the hypotheses, signifying that the proposed model is both theoretically robust and statistically reliable, while underscoring the critical role of human capital in shaping IT capabilities. Thus, the study successfully achieved its objectives.

Despite these findings, as is the case with all research, one must exercise discretion when extrapolating these conclusions due to the presence of certain limitations. Primarily, the non-random selection of survey participants, namely IT managers, may have influenced the responses and introduced a degree of bias. Furthermore, as data was exclusively drawn from public organizations in Brazil, replication of this study in alternative economic, structural, and sociodemographic settings is highly recommended, thereby enabling comparative analyses.

The research carries substantial implications for both theory and practice. From a theoretical perspective, the research introduces a robust instrument for quantifying IT human capital within organizations, one that is underpinned by theory and proven to be statistically reliable. This instrument equips researchers and managers with a valuable tool for future studies aimed at thoroughly assessing the human capital of IT.

Moreover, the study's findings underscore the uniqueness of IT human capital in relation to IT capabilities, emphasizing the necessity for subsequent research to consider IT human capital as a precursor to IT capabilities rather than a mere constituent. Researchers could further explore the multifaceted relationships between IT human capital and various organizational aspects, including direct and indirect effects, as well as mediation and moderation effects. Such inquiries could enrich understanding of the mechanisms that drive the development of organizational IT capabilities and formulate strategies for the effective management of IT human capital.

From a practical standpoint, the study furnishes IT managers with a reliable instrument for a more precise measurement of IT human capital. In addition, IT and HR managers are urged to regard the significance of potential interpersonal skills and a predisposition towards self-learning when recruiting future IT team members. Finally, the study draws the attention of both researchers and managers to the construction of organizational IT capabilities. This focus is markedly more effective in achieving superior outcomes as compared to mere direct investments in IT resources, a perspective consistent with previous studies (Mata et al., 1995; Powell & Dent-Micallef, 1997; Ray et al., 2005; Stoel & Muhanna, 2009; Stratopoulos & Dehning, 2000).

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# Appendix 1 Questionnaire

| Construct | Base | Observed Variable | |
|---|---|---|---|
| Flexibility | Chen et al (2015) | FLE1 | The information systems of this organization have a high level of scalability. |
| | | FLE2 | The information systems of this organization have a high level of compatibility. |
| | | FLE3 | The information systems of this organization have a high level of modularity. |
| | | FLE4 | This organization's information systems are widely used to share information. |
| Integration | Chen et al (2015) | INT1 | This organization shares data with external entities (supplier companies, other public agencies, etc.) |
| | | INT2 | This organization connects its information systems with the systems of external entities (supplier companies, other public bodies, etc.), allowing exchanges of information in real time. |
| | | INT3 | This organization combines information from different external entities (supplier companies, other public bodies, etc.) to support decision-making. |
| Alignment | Chen et al (2015) | ALI1 | This organization's IT plans reflect the objectives of the business areas. |
| | | ALI2 | This organization's IT plans support organizational strategies. |
| | | ALI3 | This organization's IT plans consider the forces of the external environment of the organization. |
| | | ALI4 | Does the organization's strategic planning refer to IT plans? |
| | | ALI5 | Business area plans have reasonable expectations about IT. |
| Management | Chen et al (2015) | MAN1 | Compared to other public organizations, this organization stands out in terms of the effectiveness of IT planning. |
| | | MAN2 | Compared to other public organizations, this organization stands out in terms of IT project management practices. |
| | | MAN3 | Compared to other public organizations, this organization stands out in terms of security control planning, standardization, compliance and disaster recovery. |
| | | MAN4 | Compared to other public organizations, this organization stands out in terms of the effectiveness of IT policies. |
| | | MAN5 | Compared to other public organizations, this organization stands out in terms of IT assessment and control systems. |
| Reconfiguration | Oliveira et al (2016) | REC1 | Can reconfigure existing IT resources to design new products or services for business areas. |
| | | REC2 | It is able to reconfigure existing IT resources to design new products or services for citizens or customers. |
| | | REC3 | It is successful in defining its actions as new demands for IT solutions emerge. |
| | | REC4 | It is able to improvise during the performance of its activities, in order to meet the demands of the organization. |
| Hard skills | Wang et al (2014) | HSK1 | One is qualified for the development of stable applications. |
| | | HSK2 | One is qualified in computing or distributed processing (virtualization, containers etc). |
| | | HSK3 | One is qualified in network management and maintenance. |
| | | HSK4 | One is qualified in decision support systems (business intelligence, business analytics etc). |
| Soft skills | Wang et al (2014) | SSK1 | One has the capability to teach others. |
| | | SSK2 | One has the capability to plan, organize and lead projects. |
| | | SSK3 | One has the ability to plan and execute his/her work in a collective environment. |
| | | SSK4 | One has the capability to perform multiple tasks simultaneously. |
| | | SSK5 | One works well in multidisciplinary teams to solve problems in the business areas. |
| | | SSK6 | One has the capability to work cooperatively in a project team environment. |
| | | SSK7 | One has the capability to work in partnership with users. |
| | | SSK8 | One has the capability to write clear, concise and effective memos, reports and documentation. |
| Relationship with Technology | Wang et al (2014) | RWT1 | One is well informed about the main factors that must be present for the organization to be successful. |
| | | RWT2 | One is encouraged to learn new technologies that can be applied in the organization. |
| | | RWT3 | One closely follows current technology trends. |
| | | RWT4 | One has a clear understanding that IT actions must be planned and carried out consistently and over the long term. |
| | | RWT5 | One has a willingness to learn and employ new techniques. |