Intellectual capital dimensions: state of the art in 2014

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Abstract

Purpose – The purpose of this paper is to review extant literature to identify models intended to measure/classify intellectual capital (IC) to establish the current body of knowledge that has been built since the review by Marr *et al.* (2004).

Design/methodology/approach – The study consists of a systematic review of peer-reviewed articles on IC classification. The review was conducted for the period 2004-2014 in order to reach the aim. To ensure that all major models are included, important works developed prior to 2004 were captured as well.

Findings – The review resulted in 83 additional models indicating continued research activities with regard to the topic. These models were merged with prior IC models and mapped on a timeline. The timeline clarifies that 2008, 2010, 2011, 2012 and 2013 represent the years of greatest research activity (outcomes). Additionally, the analysis of the list of IC frameworks resulted in the development of an IC Meta model. It synthesizes research activities in the field and highlights the main IC dimensions and sub-dimensions.

Research limitations/implications – This study may not have enabled a complete coverage of all existing peer-reviewed articles in the field of IC classification. Yet, it seems reasonable to assume that the review process covered a large proportion of studies available.

Originality/value – By aggregating and consolidating the IC frameworks covered, the study does not only provide an IC Meta model, but also promising directions for future research.

Keywords Intellectual capital, IC, IC frameworks, IC models, Intellectual capital dimensions, Systematic literature review

Paper type Literature review

1. Introduction

Ten years ago Marr *et al.* (2004) reviewed models intended to measure intellectual capital (IC). At that time, measuring IC or knowledge was in a developmental stage, and several academics as well as practitioners tried to come up with frameworks that took the specific nature of IC/knowledge better into consideration. Were they successful in reaching this aim? Has a standard perspective of IC been established (Edvinsson and Kivikas, 2007) which would make the development of more frameworks redundant (Marr and Chatzkel, 2004)? Picking up Marr and Chatzkel's expression, what has happened with IC taxonomies as they have reached the crossroads? The present

Journal of Intellectual Capital
Vol. 16 No. 1, 2015
pp. 58-100

1469-1930
DOI 10.1108/JIC-02-2014-0021

paper's intention is to delve into this matter and detect what has happened in the field of IC models since 2004.

In the extant literature, different approaches about how IC may be classified and measured are available (e.g. Stewart, 1997; Sveiby, 1997; Brooking, 1996; Lev, 2001; Bounfour, 2003). However, despite the number of activities from both academics and practitioners, one important hurdle was detected in the past: the lack of a common language (Grasenick and Low, 2004). One explanation for this situation is certainly the divergent viewpoints of different interest groups or disciplines, or between considerations of strategy and measurement. The former is concerned with optimizing the management of knowledge resources in the company to improve performance, whereas the latter focusses on establishing standards for organizational accounting to provide stakeholders with a more comprehensive and comprehensible picture of IC expressed in terms of traditional monetary data (Petty and Guthrie, 2000). Besides these two perspectives, other research strands dealing with IC, such as human resource management, information and communication technologies, knowledge management, and sociology, can be found as well (Marr and Adams, 2004; Diefenbach, 2006), which definitely complicates the dialogue in the field. Therefore, the question is what have happened regarding this situation over the years? Has a standard IC measurement established itself? Or do we continue to see a situation in which different interest groups or disciplines come up with new proposals without taking into consideration the ones already present?

Having this in mind, the purpose of our paper is to review extant literature to identify models intended to measure/classify IC and the kind of new knowledge that has been produced regarding the measurement of IC since the review by Marr *et al.* (2004). Thereby the focus of our review will be on frameworks that have been published in peer-reviewed journals given their topicality, higher credibility and greater probability that prior research has been taken into consideration. Against the background of the relevance of IC for developing a sustainable competitive advantage (Roos and Roos, 1997; Sveiby, 1997; Van Wijk *et al.*, 2008), organizations need ways to manage and measure IC in order to monitor the success or failure of their investments in IC, otherwise an optimal allocation of scarce resources is impossible. Therefore, intense research activities in this area are still justified. According to the study's purpose, the following research questions have been formulated:

RQ1. Which studies have been conducted since 2004 that focus on IC measurement/classification?

RQ2. What were the main findings of these studies?

The paper is organized as follows: the research method employed to come close to the research problem is described in the next section. Afterwards, the results are presented and discussed. The conclusions and implications of the study are laid out in the final section. Here future research directions are highlighted as well.

2. Methodology

In the review process, the authors adopted the principles of a systematic review as recommended by Jesson *et al.* (2011) which comprises the following stages: mapping the field through a scoping review; comprehensive search; quality assessment, data extraction; synthesis and write up.

First, a research plan was developed comprising the research questions of interest, the keywords, and a set of inclusion and exclusion criteria. The paper's aim was to determine the current status of research on IC frameworks since the work conducted by Marr *et al.* (2004). The research questions formulated, as outlined above, were:

RQ1. Which studies have been conducted since 2004 that focus on IC measurement/ classification?

RQ2. What were the main findings of these studies?

To help answer the research questions inclusion and exclusion criteria were specified. The inclusion criteria were: publications in the period 2004-2014, peer-reviewed articles, English, French, Spanish, Portuguese and German language, and Scopus and Web of Science databases. Papers published prior to 2004, books, gray literature such as reports and non-academic research, languages other than the listed ones and other databases than the two mentioned databases represented exclusion criteria. Additionally, an excel data sheet was produced consisting of key aspects related to the research aim. In the given case, these were: name of author(s), year of publication, research aim/objectives, theoretical perspective/ framework, method, main findings and name of the journal.

Second, once all relevant issues had been specified, two authors accessed the databases and looked for suitable articles. The initial search used the keyword combinations "IC" and "model" or "framework" or "definition" or "dimensions." It resulted in 696 articles from Scopus and 678 from Web of Knowledge. Removing the duplicates resulted in 386 documents.

Third, all authors individually worked through the abstracts and, if relevant, further sections of the articles to make sure that they actually covered the pre-defined scope. This procedure yielded a final selection of 83 articles, which fulfilled the set criteria and thus represented the basis of analysis.

Fourth, the 83 papers were divided among two members of the research team; thus each author read approximately 41 papers. Subsequently, the authors entered the relevant data regarding the research aim into the excel sheet. Then, all authors jointly went through each data entry and discussed the content. In the case of possible reservations on the part of the authors who had not read the paper, all authors went through the paper in question. This approach helped to reduce the danger that the analysis, and thus the conclusion drawn, might not be consistent.

Fifth, the final excel sheet was jointly discussed. This discussion enabled the research team to categorize the findings under IC dimensions, which, in turn, helped to clarify what body of knowledge of IC frameworks has been established over time.

Sixth, the final stage of the review process was devoted to writing up the findings.

The 83 papers were published in 31 different journals (Table I). It is not surprising that the largest number of papers was published in the *Journal of Intellectual Capital*. The journals can be assigned to the fields of information and knowledge management (nine journals), business and management (five journals), business, management and accounting (four journals), computer science (four journals), and public sector management (two journals). The remaining journals address fields such as innovation, economics, hospitality management and tourism, industrial organization, decision sciences, sector studies and international business and area studies. This suggests IC framework research interests a broad audience.

Journal	Frequency
Journal of Intellectual Capital	36
Expert Systems with Applications	6
VINE – The Journal of Information and Knowledge Management Systems	4
Management Decision	3
Industrial Management and Data Systems	2
Information and Management	2
Intangible Capital	2
Journal of Knowledge Management	2
Knowledge Management Research and Practice	2
Measuring Business Excellence	2
R and D Management	2
Advances in Fuzzy Systems	1
Decision Sciences	1
Education, Business and Society: Contemporary Middle Eastern Issues	1
European Business Review	1
Expert Systems	1
Foresight	1
Government Information Quarterly	1
Information and Organization	1
International Journal of Hospitality Management	1
International Journal of Intelligent Enterprise	1
International Journal of Management and Decision Making	1
Journal of Accounting and Organizational Change	1
Journal of Construction Engineering and Management	1
Journal of Information and Knowledge Management	1
Journal of Information Science	1
Journal of International Business Studies	1
Journal of the Knowledge Economy	1
Knowledge and Process Management	1
Periodica Polytechnica, Social and Management Sciences	1
Supply Chain Management	1

Table I.
Information about published and cited papers on IC frameworks

3. Presentation and discussion of findings

The outcomes of the authors' analytical reflections are summarized in Table II and Figure 1. Table II consolidates existing IC models. It consists of IC frameworks that have been proposed after Marr *et al.* (2004). Additionally, it includes some of the important works in the field which were developed before 2004. Therefore, Table II provides a holistic overview of research activities into IC frameworks originating from 1996.

For the creation of Table II, the research team analyzed all identified IC models. Thereby, the researchers individually analyzed the models and later compared and discussed their findings. This approach resulted in the identification of 11 main dimensions of IC capital (i.e. customer, structural, human, innovation, business, organizational, processes, relational, relational and customer, social and technological) that were used to categorize the different IC framework components. These were used as they represent elements typically applied in classical IC frameworks (e.g. Edvinsson and Malone, 1997; Stewart, 1997). All of these dimensions served as table headers. Consequently, the different types of capital dimensions as identified in the frameworks are presented in the columns. More precisely, the dimensions are presented in the

Table II.
IC models analyzed

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
Edvinsson and Sullivan (1996)		1st level 2nd level (St) Intellectual Assets	1st level 2nd level (H) Human Resources									One of the first model to define IC Giving greater prominence to human capital, i.e. providing a second level
Edvinsson and Malone (1997)	2nd level (St)	1st level	1st level	3rd level (O)		2nd level (St)	3rd level (O)					This model represents a further development of the work by Edvinsson and Sullivan. The updated model highlights the structural capital but does no longer take into account the 2nd level of the human capital The emphasis of the model is on processes associated with innovation as a 3rd level of structural capital
Roos and Roos (1997)			1st level 2nd level Motivational Skills Tasks Knowledge			1st level 2nd level Business Renewal and Development capital 3rd level Specialization Production Processes New Concepts Sales and marketing New co- operation forms 2nd level Business Process 3rd level			1st level 2nd level Customer, Supplier, Channel partners and investor relationships			One of the most cited models. The authors present a broad vision of IC in organizations. The model highlights the production process, forms of co-operation and relationships with both internal and external customers The authors stress the role of individuals regarding ownership and control of knowledge resources

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
						Flow of Information Flow of products and services Co-operation forms Strategic processes						
Wiig (1997)	2nd level (St)	1st level	1st level	3rd level (O) 4th level Intellectual Property Intangible Assets		2nd level (St)	3rd level (O)					Wiig emphasizes the organizational part, including a 4th level, which unfolds in innovation: intellectual property and intangible assets Wiig points to the need of managing and processing innovation The model is based on Stewart (1997), and Sveiby (1997)
Stewart (1997)	1st level	1st level	1st level									This author asserts that value creation is the outcome of the exchange between human, structural and customer capital. Customer capital can also be called relational capital
Sveiby (1997)		1st level Internal structure	1st level Employee Competence						1st level External structure			This author stresses that the intangible assets listed on the invisible balance sheet are the ones that constitute the IC
Bontis (1999)		1st level	1st level						1st level			This author's model is based on Stewart (1997), Edvinsson and Sullivan (1996), Edvinsson and Malone (1997), Sveiby (1997), Roos and Roos (1997), and Bontis *et al.* (1999)

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Bontis *et al.* (1999)		1st level 2nd level Organization Renewal and Development Relationship	1st level 2nd level Competence Intellectual Agility Attitude									The authors add a 2nd level of the structural aspect of a relationship They argue that beyond the skills and attitudes, intellectual agility is needed The framework is based on Edvinsson and Malone (1997), Bontis (1999), and Roos and Roos (1997)
Lev (2001)	1st level 2nd level Brands and Trademarks		1st level 2nd level Training and compensation system			1st level 2nd level Organization design and business process					1st level	According to Lev, IC is the way to innovate in organizations It is the major driver to corporate value and growth
Francini (2002)		1st level	1st level	2nd level			2nd level	2nd level				The work is based on Sveiby (1997), and Edvinsson and Malone (1997) The author treats human capital as the sum of the employees' skills The model emphasizes the structural part of processes, relationships and innovation
Rodov and Leliaert (2002)	1st level 2nd level Reference List Duration Customer Type Revenue Potential Success Customer	1st level 2nd level Org. Structure Org. Process Software Database Partners Network Value chain Leverage Brand	1st level 2nd level Competence Reputation Experience Innovation Skills Customer Closeness Org. Learning Culture	2nd level								The authors took a financial perspective and tried to link the IC value to the market valuation over and above book value It is based on Bontis (1999), Bontis *et al.* (1999), Edvinsson and Sullivan (1996), Stewart (1997), and Sveiby (1997)

(*continued*)

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
	Closeness Value chain Leverage Brand Trademark Integrated relationship Knowledge Product Patents Data	Trademark Org. Learning Culture Org. Technology Integrated relationship Knowledge Product Patents Data	Org. Technology Integrated relationship Knowledge Product Patents data									
Bueno *et al.* (2002a, b)		1st level	1st level						1st level			This author emphasized the use of performance indicators for each of the IC dimensions
Bounfour (2003)		1st level Named: Resources and Competence	1st level Named: Resources and Competence				1st level				1st level Named: outputs measured, through an analysis of a firm's product and service market positioning	Bounfour tried to solve the IC issue by integrating the four dimensions into the problem of corporate competitiveness. He recommends to no longer considering IC from the (often static) perspectives of market share or industry's structure This work is based on Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997)
Bueno *et al.* (2003)		1st level	1st level		2nd level (R)	2nd level (St)			1st level	2nd level (R)	2nd level (St)	This work is based on prior work by Bueno *et al.* (2002a, b), which emphasizes the 2nd level Thereby the focus is on organizing and supporting the company, technological tools, and on relations with clients and their business
Castro and Muiña (2003)			1st level			1st level		1st level			1st level	The authors regard the structural capital as both organizational capital and technological capital

(*continued*)

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Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
												It is based on Edvinsson and Malone (1997), Roos and Roos (1997), Stewart (1997), and Sveiby (1997)
Marr *et al.* (2004)		1st level Called: Structural resources 2nd level Physical infrastructure Virtual infrastructure 3rd level (Virtual infrastructure) Culture routines and practices Intellectual property	1st level Called: Stakeholder resources 2nd level Stakeholders relationship Human resources									The authors introduce the Knowledge Asset Map and Knowledge Asset Dashboard in order to provide organizations with a comprehensive tool that can help them to identify their key knowledge assets It is based on Edvinsson and Sullivan (1996), Edvinsson and Malone (1997), Roos and Roos (1997), Stewart (1997), Sveiby (1997), Bontis *et al.* (1999), and Lev (2001)
Chen *et al.* (2004)	1st level	1st level	1st level	1st level								These authors do not consider innovation capital as part of structural capital sThey stress that innovation capital can give an impetus to the growth of customer capital It is based on Bontis *et al.* (1999) and Edvinsson and Malone (1997)
Jacobsen *et al.* (2005)	2nd level (R)		1st level 2nd level Management Employees			1st level (called Organizational Structural Capital) 2nd level	2nd level (O)	1st level (called Relational Structural Capital) 2nd level Network Brand				The model is based on Sveiby (1997), indicating a division in internal, external and market assets, and the work by Leif Edvinsson at Skandia (Edvinsson and Malone, 1997)

(*continued*)

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Cordazzo (2005)	1st level		1st level			Intellectual properties 1st level						Showed a quite relevant set of common information between the environmental and social reports and the IC statements Based on Sveiby (1997)
Cuganesan (2005)	2nd level (R)	1st level	1st level					1st level 2nd level Suppliers – specific expertise				The actual IC inter-relationships and transformations that occurred were different to those originally envisaged by organizational participants, and reflected choices about IC deployment and transformation Based on Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997)
Leitner (2005)		1st level	1st level					1st level				The presented model tries to visualize the knowledge-production process and contributes to an improved understanding of the knowledge-production process within ARC
Tseng and Goo (2005)			1st level	1st level		1st level		1st level				The authors demonstrate the positive influence of human capital on innovation, organization and relationship capital Organization capital influences innovation and relationship capitals, and innovation capital influences relationship capital Based on Edvinsson and Malone (1997), Roos and Roos (1997), Stewart (1997) and Sveiby (1997), Bontis (1999), Bontis *et al.* (1999),

(*continued*)

Table II.

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Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
												Roos and Roos (1997), Stewart (1997), and Sveiby (1997)
Subramaniam and Youndt (2005)			1st level			1st level		1st. level Called Social				Showed the close tie between human capital and social capital and the critical role of social capital regarding innovations Based on Schultz, (1961), Davenport and Prusak (1998), and Nahapiet and Ghoshal (1998)
Wang and Chang (2005)	3rd level		1st level	2nd level			2nd level					Findings showed that IC elements directly affect business performance, with the exception of human capital The latter indirectly affects performance through the other three elements: innovation capital, process capital, and customer capital
Litschka *et al.* (2006)			1st level 2nd level Knowledge Abilities, Skills Workability Motivation Job satisfaction Commitment			1st level 2nd level Constitutions Policy and Mission Structure Processes Culture						1st level – Organizational Assets 2nd level Intellectual property rights Stakeholders related CA Process related CA Product related CA The authors proposed a quantitative IC assessment model for companies Based on Edvinsson and Malone (1997)
Martínez-Torres (2006)		1st level	1st level					1st level				The author used the classical IC model to understand the intellectual wealth of a learning organization Based on Stewart (1997), Sveiby (1997), and Edvinsson and Malone (1997)

(*continued*)

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Montequin *et al.* (2006)		1st level 2nd level ITC penetration Product technology Process and business philosophy Organization structure Intellectual property	1st level 2nd level People's competence Competence improvement Staff stability Improvement of capacity of persons and groups					1st level 2nd level Customer base Customer loyalty Market proximity Sales Effectiveness Suppliers Interrelation with other actors				The authors identified, analyzed and compared IC elements that are relevant for SMEs and showed how those elements can be linked with IC measurement methods in order to determine if a company is ready for KM Based on Sveiby (1997), Edvinsson and Malone (1997), and Wiig (1997)
Namasivayam and Denizci (2006)	1st level	1st level	1st level									The authors present the formation of customer capital being the intersection of human and structural capital Based on Edvinsson and Sullivan (1996), Stewart (1997), Sveiby (1997), and Bontis (1999)
Ng (2006)	3rd level	2nd level	2nd level	2nd level								1st level = Financial Capital The author presents a framework for IC flow He suggests an "add-on" disclosure of IC flow in order to enhance the usefulness and predictability of company performance Based on Marr *et al.* (2004)
Swart (2006)	1st level	1st level	1st level			1st level		1st level Called Network Capital		1st level		This author proposed an IC model in which measurable subcomponents are dynamically integrated Based on Edvinsson and Sullivan (1996), Stewart (1997), and Sveiby (1997)

(*continued*)

Table II.

Table II.

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
Huang *et al.* (2007)	1st level 2nd level Market Perspective Data on customers Customers services and relationship	1st level 2nd level Development of Products/ Ideas Organization Infrastructure	1st level 2nd level Employee Capabilities Employee development and Retention Employee Behavior									The author examined the extent to which the IC classification proposed in the normative IC literature is supported by perceived reality of information available in companies Based on Bontis (1999), Edvinsson and Malone (1997), Edvinsson and Sullivan (1996), Stewart (1997), and Sveiby (1997)
Nathan and Ribière (2007)		1st level	1st level							1st level		The authors present an IC model of IFIs boards Based on Stewart (1997), Sveiby (1997), Wiig (1997), Bontis (1999), and Lev (2001)
Nazari and Herremans (2007)	2nd level	1st level	1st level			2nd level	3rd level Renewal					The authors present IC taxonomy and extended the VAIC model to measure IC Based on Edvinsson and Sullivan (1996), Stewart (1997), Sveiby (1997), Edvinsson and Malone, 1997, and Bontis (1999).
Ramírez *et al.* (2007)		1st level	1st level					1st level				The authors used the MERITUM results as basis for the development of IC indicators for evaluating universities Based on Bontis (1999), Edvinsson and Malone (1997), and Stewart (1997).
Rudež and Mihalič, (2007)	1st level (Named: End-customer relationship capital) 2nd level	1st level 2nd level Culture Management philosophy Business processes	1st level 2nd level Employee competence Employee attitudes to work					1st level (Named: Non-end-customer relationship capital) 2nd level Relationships				The novelty of this IC model for hotels is the division of relationship capital into end-customer-relationship and non-end-customer-relationship capital Based on Bontis *et al.* (1999),

(*continued*)

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
	Customer satisfaction and loyalty Image and brand Direct distribution channels	Information technology	Employee innovativeness					with commercial partners Relationships with other partners and groups				Lev (2001), Stewart (1997), and Sveiby (1997).
Sällebrant *et al.* (2007)		1st level	1st level 2nd level Management Employees				2nd level (ST) Intellectual	1st level 2nd level Networks Brand Customers				The authors examined the relationship between risk and transparency with regards to a company's IC assets Based on Bontis (1999) and Bontis *et al.* (1999)
Sánchez-Cañizares *et al.* (2007)			2nd level			2nd level		2nd level		2nd level	2nd level	The authors proposed a model that focusses on the organizational culture The cultural capital is defined at two levels: (1) national culture and (2) organizational culture Based on Edvinsson and Malone (1997), and Bontis (1999)
Tovstiga and Tulugurova (2007)		1st level 2nd level Renewal and Development (R&D , Organizational learning)	1st level 2nd level Competence (knowledge, capabilities, skills) Attitudinal (motivation, behavior, mindset) Intellectual agility (innovation, imitation, adaptation)			2nd level (SC) Structure Infrastructure Process Culture		2nd level (SC) Network partners Alliance partners Customers/ suppliers				The authors' present, apart from the IC components, environmental factors as external factors (socio-political, technological and economic) in order to enhance performance Based on Stewart (1997) and Bontis (1999)

(*continued*)

Table II.

Table II.

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
Choong (2008)	1st level	1st level 2nd level Development Technology	1st level 2nd level Knowledge Competence	1st level Called: Intellectual Property Capital 2nd level Brands Rights								The author developed a method to evaluate tangibles and intangibles (Value Chain Performance Measure System) This author demonstrates that the field of IC is maturing to one in which it is possible to analyze existing IC definitions and classifications to construct a formal body of items that can be Used Based on Bontis *et al.* (1999), Edvinsson and Malone (1997), Lev (2001), Bueno *et al.* (2002a), Roos and Roos (1997), Stewart (1997), and Sveiby (1997)
Liang and Lin (2008)	1st level		1st level	1st level			1st level					The authors investigated value-relevant information provided by IC beyond financial performance in different life-cycle stages Based on Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997).
De Castro and Sápez (2008)		1st level	1st level Called Experienced and Innovative HC					1st level				The authors' work fits the dominant IC structure proposed by other authors Based on Edvinsson and Malone (1997), Sveiby (1997), and Subramaniam and Youndt (2005)
Joia (2008)		1st level	1st level 2nd level External capital	2nd level (St)		2nd level (St)						According to the author, IC is the sum of HC and SC Based on Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997)
Massingham (2008)		1st level	1st level					1st level		1st level		The author stresses the differentiation between relational

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
												and social capital He also highlights the contribution of social actions to value creation
Tóth and Kövesi (2008)	1st level	1st level	1st level									1st level Strategic Alliance Capital The authors tried to answer the question as to how the EFQM method can support an organization in its efforts to evaluate some of its IC elements Based on Edvinsson and Malone (1997), Stewart (1997), Sveiby (1997), Roos and Roos (1997), and Bontis (1999)
Sharma *et al.* (2008)		1st level 2nd level Infrastructure Governance	1st level					1st level 2nd level Culture				The authors proposed a framework to analyze society based knowledge in terms of the classical IC model (HC, SC & RC) They propose 13 dimensions to evaluate the way societies reach knowledge
Martín-Castilla and Rodríguez-Ruiz (2008)			1st level			1st level		1st level				The authors showed the role of IC in the EFQM model. So it is possible to define relationships between each component of the IC navigators and those coming from the ERQM model.
Schneider and Samkin (2008)			1st level									1st level Internal Capital External Capital The authors looked into IC reporting of local government authorities. The most reported IC category was internal capital, followed by external capital

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Sonnier (2008)	1st level		1st level			1st level						Human capital was the least reported category Based on Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997) The author defines a resource-based view IC Model which is divided into internal resources (Financial assets, physical assets, human capital, intellectual property) Capabilities (Organizational capital) External resources (Customer capital, supplier capital) Based on Edvinsson and Sullivan (1996), Edvinsson and Malone (1997), Lev (2001), Stewart (1997), and Sveiby (1997)
Chen (2009)		1st level 2nd level Organizational Infrastructure Organizational patents, trademarks	1st level 2nd level Employee's capabilities Employee's knowledge Employee's skills Employee's technical	1st level 2nd level Frequent updating Upgrading capabilities				1st level 2nd level Customer's retention/ loyalty Close relationship with internet communities Close relationship with suppliers				1st level Called Service capital 2nd level Quick response to complaints Reliability Security Customization It is based on Bontis (1999), Edvinsson and Sullivan (1996), Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997)
F-Jardón and Martos (2009)		1st level	1st level					1st level				The authors argues that the only IC dimension directly affecting performance is structural capital The other dimensions exert an indirect effect through structural capital Based on Bontis (1999),

(*continued*)

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
												Edvinsson and Malone (1997), and Wiig (1997)
Kong and Thomson (2009)		1st level	1st level					1st level				The authors aimed to show the link between IC and both SHRM and HRM It is based on Bontis (1999), Stewart (1997), and Sveiby (1997)
Longo *et al.* (2009)		1st level	1st level					1st level				The authors studied the effect of IC on the performance of organizations operating in the performing arts sector
Rodrigues *et al.* (2009)		1st level	1st level					1st level				Based their model on Bontis (1999), Bontis *et al.* (1999), Edvinsson and Sullivan (1996), Edvinsson and Malone (1997), Roos and Roos (1997), Stewart (1997), and Sveiby (1997)
Sharma *et al.* (2009)		1st level 2nd level Infrastructure Governance	1st level					1st level 2nd level Culture				The authors applied their on framework (Shama *et al.*, 2008) in a different setting
Stam (2009)		1st level	1st level					1st level				The author asserts that IC should be defined as intellectual assets minus intellectual liabilities, thus highlighting the risky side of IC It is based on Bontis *et al.* (1999), and Edvinsson and Malone (1997)
Tai and Chen, (2009)	1st level 2nd level Market share rate Number of major customers		1st level 2nd level Ratio of employee leave Output value of each employee	1st level 2nd level Number of new product or process Number of patents		1st level 2nd level Company brand Trademark Information system						The authors used the fuzzy method to evaluate IC using linguistic variables Based on Stewart (1997), Sveiby (1997), and Wiig (1997)

(*continued*)

Table II.

Table II.

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
	Customer loyalty		Training hour of each employee	Fee of research/fee of total		Index of productivity						
Tovstiga and Tulugurova (2009)		1st level 2nd level Renewal and Development (R&D , Organizational learning)	1st level 2nd level Competence (knowledge, capabilities, skills) Attitudinal (motivation, behavior, mindset) Intellectual agility (innovation, imitation, adaptation)			2nd level (SC) Structure Infrastructure Process Culture		2nd level (SC) Network partners Alliance partners Customers/ suppliers				The authors' applied their model in different areas Based on Stewart (1997), Bontis (1999), and Tovstiga and Tulugurova (2007)
Andrikopoulos (2010)		1st level	1st level			2nd level (St)		2nd level (St)				The author analyzed IC as a tool to meet practical needs with respect to accounting for managing knowledge-based intangible wealth It is based on Bontis (1999), and Edvinsson and Sullivan (1996)
Halim (2010)		1st level	1st level 2nd level Professional Competence Social Competence Employee Motivation Leadership ability					1st level				This author claims that among the 15 indicators presented, 14 indicators have strong correlation with the respective IC dimensions
Laing *et al.* (2010)		1st level 2nd level Structural Capital Efficiency	1st level 2nd level Human Capital Efficiency 3rd level									These authors developed efficiency indicators to measure IC It is based on Chen *et al.* (2004), Wang and Chang (2005),

(*continued*)

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
		3rd level Intellectual capital efficiency	Intellectual capital efficiency									Lovingsson *et al.* (2000), Kaplan and Norton (1996), Sveiby (1997), Edvinsson and Malone (1997), and Edvinsson and Sullivan (1996)
Lee (2010)		1st level	1st level					1st level				The author used the classical IC dimensions to develop an IC evaluation model to understand the contribution of IC to university performance better Based on Edvinsson and Malone (1997), and Stewart (1997)
Namvar *et al.* (2010)		1st level	1st level					1st level				The authors presented the relationship between the IC components and company performance The findings indicated that Intellectual Property significantly influences other IC dimensions Based on Bonfour (2003), Edvinsson and Malone (1997), Roos and Roos (1997), Stewart (1997), and Sveiby (1997).
Malavski *et al.* (2010)		1st level 2nd level Infrastructure Assets Intellectual property	1st level					1st level				These authors suggest that structural capital consists of organizational processes, software, procedures, systems, culture, and database It is based on Edvinsson and Malone (1997), Sveiby (1997), and Stewart (1997)
Ramírez (2010)		1st level	1st level					1st level				The author applied the three classical IC dimensions to measure IC in the Public Sector It shows the importance of IC

(*continued*)

Table II.

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
												approaches to address the public sector's new challenges Based on Sveiby (1997) and Stewart (1997)
Secundo *et al.* (2010)			1st level 2nd level Attractiveness Efficiency			1st level 2nd level Innovation Knowledge codification Infrastructure development		1st level				The authors developed a framework based on the classical IC dimensions to measure IC in higher education and research It highlights the usefulness of a dashboard for stakeholder communication with stakeholders and a tableau de bord for strategic decision making They also emphasized the role of a network of relationships related to *R&D* to improve and accumulate the IC Based on Bontis *et al.* (1999), Edvinsson and Malone (1997), Sveiby (1997), Stewart (1997), and Marr *et al.* (2004)
Sharabati *et al.* (2010)		1st level	1st level						1st level			The authors tested the correlation of the three IC dimensions and compared their results with previous studies Based on Stewart (1997) and Bontis (1999)
Wu *et al.* (2010)				1st level named: Intellectual Property Tangible assets 2nd level Innovative								The author developed a fuzzy model to measure IC in universities Based on Edvinsson and Malone (1997), Sveiby (1997), Stewart (1997), and Subramaniam and Youndt, (2005)

(*continued*)

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
				Culture Innovative Reference Number of new ideas Number of publications Financial support Research performance 3nd level (associated with all 2nd levels) Research intensive university Teaching intensive university Professional intensive university								
Velmurugan (2010)	1st level	1st level	1st level									The author tried to give an explanation of why accounting bodies are hesitant to embrace new IC valuation and reporting models, in spite of the fact that accounting standards are ill-suited to cater for intangibles
Abhayawansa (2011)			1st level									Added: 1st level Internal Capital External Capital The author described a methodology as to what and how

(*continued*)

Table II.

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Bueno *et al.* (2011)		1st level	1st level	Considered as one accelerator of the other ones proposed	2nd level	2nd level		1st level		2nd level	2nd level	IC information is communicated in analyst reports Based on Sveiby (1997) Is based on prior work by Bueno *et al.* (2002a, b) The authors proposed the inclusion of accelerators when studying IC
Demartini and Paoloni (2011)		1st level 2nd level Products Innovation Patents and Trademarks Knowledge DataBases	1st level 2nd level Skills Competences Behaviors				2nd level (St)	1st level 2nd level Partners/ Suppliers relations Communities and Academic relations Corporate Images Customers Relations				Focussing on a high-tech service company, the authors underline the relevance of a firm's project management organization when measuring IC Based on Edvinsson and Malone (1997)
Elena-Pérez *et al.* (2011)		1st level	1st level					1st level				The authors illustrate how foresight contributes to the study of IC IC is the human, structural and relational Capital found in resources and activities It is based on Edvinsson and Malone (1997), Kaplan and Norton (1996), Lev, (2001), Marr (2005), and Sveiby (1997)
Grajkowska (2011)			1st level			1st level 2nd level IP 2nd level Explicit knowledge Other Intangibles		1st level 2nd level Customer Value Partner Value				The author proposed a way of calculating a fair share of an innovative company's shareholdings

(*continued*)

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Maditinos *et al.* (2011)		1st level	1st level									1st level Capital Employed Efficiency The findings indicate that there is a significant relationship between human capital efficiency and financial performance Based on Bontis (1999), Edvinsson and Malone (1997), Stewart (1997), Sveiby (1997), and Lev (2001)
Morris and Snell (2011)		1st level 2nd level Social interaction Shared vision 3rd level Sharing capability	1st level 2nd level Local experience International experience 3rd level Generation capability			1st level 2nd level Codifying systems 3rd level Implementation capability						The authors developed and tested a framework that examines the relationship between IC configurations and organizational capabilities in human resource (HR) subunits Based on Bontis (1999)
Phusavat *et al.* (2011)		1st level Tax scheme and incentives for R&D spending and promotion of university partnership	1st level Training on knowledge management practices									The authors applied the value added intellectual coefficient (VAIC) to measure IC IC positively affects firm's performance In addition, human capital exhibits the relationships with employee productivity Based on Edvinsson and Malone (1997), Stewart (1997), Sveiby (1997), and Bontis (1999)
Seleim and Khalil (2011)			1st level			1st level		1st level				The authors utilize descriptive statistics to establish the correlation of IC with Knowledge acquisition, Knowledge creation, Knowledge Documentation, Knowledge Transfer and Knowledge Application

(*continued*)

Table II.

Table II.

Author(s)	Capital dimensions											Analysis
	Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	
												The analysis revealed three patterns of relationships between KM and IC Based on Bontis (1999), Edvinsson and Sullivan (1996), Edvinsson and Malone (1997), Stewart (1997), and Marr *et al.* (2004)
St-Pierre and Audet (2011)			1st level	1st level			1st level	1st level				In line with Chen *et al.* (2004), the authors show the influence of human capital on innovation and process capital Contrary to Wang and Chang (2005) HC does not play a significant role regarding relational capital. Also, in contrast to observations by Chen *et al.* (2004), and Wang and Chang (2005) innovation capital is not linked to performance
Fan and Lee (2012)		1st level 2nd level Systems and Processes	1st level 2nd level Knowledge Workers Transformational Leaders	2nd level (St) Called Innovation Culture				1st level 2nd level Internal Social Network External Social Network				The authors present a methodology to study the relationship between IC and innovation performance Based on Bontis (1999).
González-Loureiro and Dorrego (2012)		1st level	1st level					1st level				The authors show the contribution of the IC dimension to SME growth The findings show that HC does not work alone, it needs support by SC (mainly) and RC (to a lesser degree) It is based on Bontis (1999), Edvinsson and Malone (1997), Edvinsson and Sullivan (1996), Stewart (1997), Sveiby (1997), and Subramanian and Youndt (2004).

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Hsu and Sabherwal (2012)			1st level			1st level				1st level		Their model is based on Edvinsson and Malone (1997), Wiig (1997), and Youndt and Subramanian (2004)
Jardon and Martos (2012)		1st level	1st level					1st level				The authors show the influence of different capabilities (e.g. organizational capabilities) and variables (e.g. territory) on performance It is based on Edvinsson and Malone (1997), and Kaplan and Norton (1996)
Ling (2012)		1st level	1st level					1st level				The author uses the classical IC model to explain a firm's global initiatives The findings confirmed a positive association between IC and those global initiatives Based on Edvinsson and Malone (1997), Stewart (1997), Sveiby (1997), and Subramaniam and Youndt (2005)
Ramezan (2012)		1st level	1st level							1st level		This author used the concept social capital The analysis presented indicated the positive impact of learning (individual, group and organization) have positive impact on the IC dimensions (human, social and structural) Based on Edvinsson and Malone (1997), and Stewart (1997)
Sussan (2012)		1st level	1st level				2nd level (SC)		1st level 2nd level B2C interaction C2C interaction			The author extends the model of Edvinsson and Malone (1997) and Stewart (1997) by focussing on the relational aspect

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
												Based on Edvinsson and Malone (1997), Stewart (1997), and Bontis (1999)
Yi (2012)		1st level 2nd level Technology innovation Infrastructure IPR Organizational culture	1st level 2nd level Employee competence Work attitude Employee satisfaction Employee retention					1st level 2nd level Customer satisfaction Brand R&D network R&D value creation				The author developed Key Performance Indexes for a Korean public research institute The IC second level forms the basis for the KPIs development This work is based on Stewart (1997), Sveiby (1997), Edvinsson and Malone (1997)
Zarandi *et al.* (2012)	1st level 2nd level Market share rate Customer loyalty Customer satisfaction Customer relationship	1st level 2nd level Trademarks Operation process Information system Corporate culture	1st level 2nd level Employee's knowledge Innovativeness Satisfaction degree Employee's turnover rate									A fuzzy rule-based expert system is proposed to reveal and evaluate the overall performance degree of IC Based on Wiig (1997), Edvinsson and Malone (1997), Sveiby (1997), Stewart (1997), and Chen *et al.* (2004)
Calabrese *et al.* (2013)		1st level 2nd level Renewal and Development	1st level 2nd level Competence Attitude Intellectual Agility			2nd level (St)		2nd level (St)				They propose a model for IC evaluation by integrating Fuzzy Logic and Analytic Hierarchy Process
Córcoles (2013)		1st level 2nd level Bibliograhic resources Resources from empirical primary data	1st level 2nd level Full-time researchers Researchers qualification Research incentives					1st level 2nd level Participation in scientific meetings Membership in scientific associations				The author provides an understanding of how European universities are measuring and managing their IC Based on Edvinsson and Malone (1997) and Stewart (1997)

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
		Basic infrastructure	Full-time administrative staff					Collaboration with firms and other institutions				
Cricelli *et al.* (2013)		1st level 2nd level Intellectual property & Technology Corporate culture and internal relationships	1st level 2nd level Knowledge Competence				2nd level (St)	1st level 2nd level Rel. with institutions, with investors, with partners and suppliers, with customers				The authors propose a framework designed to support the top management in the tactical and strategic planning of the investments on critical ICAs. Based on Bontis (1999), Edvinsson and Malone (1997), Stewart (1997), Sveiby (1997), and Wiig (1997)
Dumay and Roslender (2013)		1st level 2nd level Organization Structure	1st level 2nd level Employee Skills Employee Attitude Intellectual Liveliness Organization Culture	2nd level (St) Called Innovation Capacity				1st level 2nd level Customer and Supplier Contracts Organization Structure				The authors proposed that organizations may benefit from considering how the development of IC fits with the strategic intent of the organization Based on Sveiby (1997)
Demartini and Paoloni (2013a)		1st level	1st level					1st level				The authors developed a model of IC management It is based on Bontis (1999), Edvinsson and Malone (1997), Kaplan and Norton (1996), Stewart (1997), and Sveiby (1997)
Demartini and Paoloni (2013b)		1st level 2nd level Portals and processes Databases	1st level 2nd level Skills/ Competence Behavior Knowledge on regulation/ engineering					1st level 2nd level International relations Reputation Institutional relations				The authors demonstrate that is possible and also convenient to overlap the tasks to be done in the process of drawing up the ICS and the CSRS Based on Sveiby (1997).

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Grimaldi *et al.* (2013)		1st level 2nd level Intangible Infrastructural Assets Information Technology Intellectual properties	1st level 2nd level Knowledge Skills Management Skills Creativity and Innovativeness	2nd level (St)				1st level 2nd level Customers Relations Inter-firms Relations Supplier Relations Financial Relations Institution Relations Brand and Image				The authors proposed a theoretical framework which defines, analyses and assesses IC value drives to increase the value creation of organizations It is based on Choong (2008), Edvinsson and Malone (1997), Lev (2001), Stewart (1997), and Sveiby (1997)
Liang *et al.* (2013)	1st level		1st level	1st level			1st level					Taiwanese OEMs engaged in manufacturing and innovation activities, and created process and innovation capital In contrast, Taiwanese OBMs developed their marketing channels, human resources, innovation centers, and social networks, and accumulated their human, customer, process and innovation capital Based on Bontis (1999), Edvinsson and Sullivan (1996), and Edvinsson and Malone (1997)
Mura and Longo (2013)		1st level 2nd level Group cohesiveness Trust Communication Contribution	1st level 2nd level Innovation Intrinsic work reflection Practical application					1st level 2nd level Networking Perception of customers				The authors developed a model for assessing and valuing the IC of an organization by gathering data from individual employees Based on Edvinsson and Malone (1997) and Sveiby (1997)

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
Piri *et al.* (2013)		1st level	1st level									As 2nd level the model has cultural capital and KM practices The authors used structural equation modeling analysis to prove the correlation of structural and human capital with organization performance The findings indicate that both cultural capital and knowledge management practices fully mediate the effects of intangible assets on organizational performance, while the latter does more Based on Sveiby (1997)
Shariatmadari and Azadi (2013)		1st level	1st level					1st level				The authors used the classical IC model and developed indicators for its evaluation Based on Roos and Roos (1997), Stewart (1997), Sveiby (1997), and Marr *et al.* (2004)
Su *et al.* (2013)	2nd level (SC)	1st level	1st level	3rd level (OC)		2nd level (SC)	3rd level (OC)					The authors proposed a framework of IC to enable relationship transparency through reporting The IC transparency supports trust, satisfaction and commitment Based on Edvinsson and Malone (1997), Stewart (1997), Marr *et al.* (2004), and Subramaniam and Youndt (2005)
Wasiluk (2013)		1st level 2nd level Internal resources	1st level 2nd level Human competence					1st level 2nd level Social citizenship, Business				The author proposed an IC taxonomy for sustainability leaders based on the junction of

(*continued*)

Table II.

Author(s)	Capital dimensions: Customers (C)	Structural (St)	Human (H)	Innovation (I)	Business (B)	Organizational (O)	Processes (P)	Relational (R)	Relational and Customers (RC)	Social (So)	Technological (T)	Analysis
		Corporate identity						relationship, Environmental health				the MERITUM project and empirical data from Allee (2000)
Kim and Taylor (2014)		1st level 2nd level Transformed part of HC Intangible assets in the balance sheet	1st level 2nd level Pure investments in HC Transforming into SC									These authors developed models to compute and compare the value-relevance of the productivity of IC (and its components of human capital and structural capital) to the value-relevance of the productivity of book-value of net assets Based on Bontis et al (1999), Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997).
Vargas and Lloria, (2014)	1st level	1st level	1st level									The authors used the variables: intention, autonomy (feedback), fluctuation, variety, redundancy and trust to check if there is a statistical correlation with performance Based on Bontis *et al.* (1999), Edvinsson and Malone (1997), Sveiby (1997), and Stewart (1997)
Wang *et al.* (2014)		1st level	1st level					1st level				The authors applied a two-stage DEA approach to calculate efficiency scores and to provide an easily interpretable efficiency index for benchmarking bank holding companies

Notes: 1st level – displays the first-level constructs (i.e. customer, structural, human, innovation, business, organizational, processes, relational, relational and customers, social and technological capital); 2nd level – displays the second-level constructs. They are assigned to the corresponding 1st level constructs; 3rd level – Displays the third-level constructs. They are associated with the corresponding 2nd level constructs

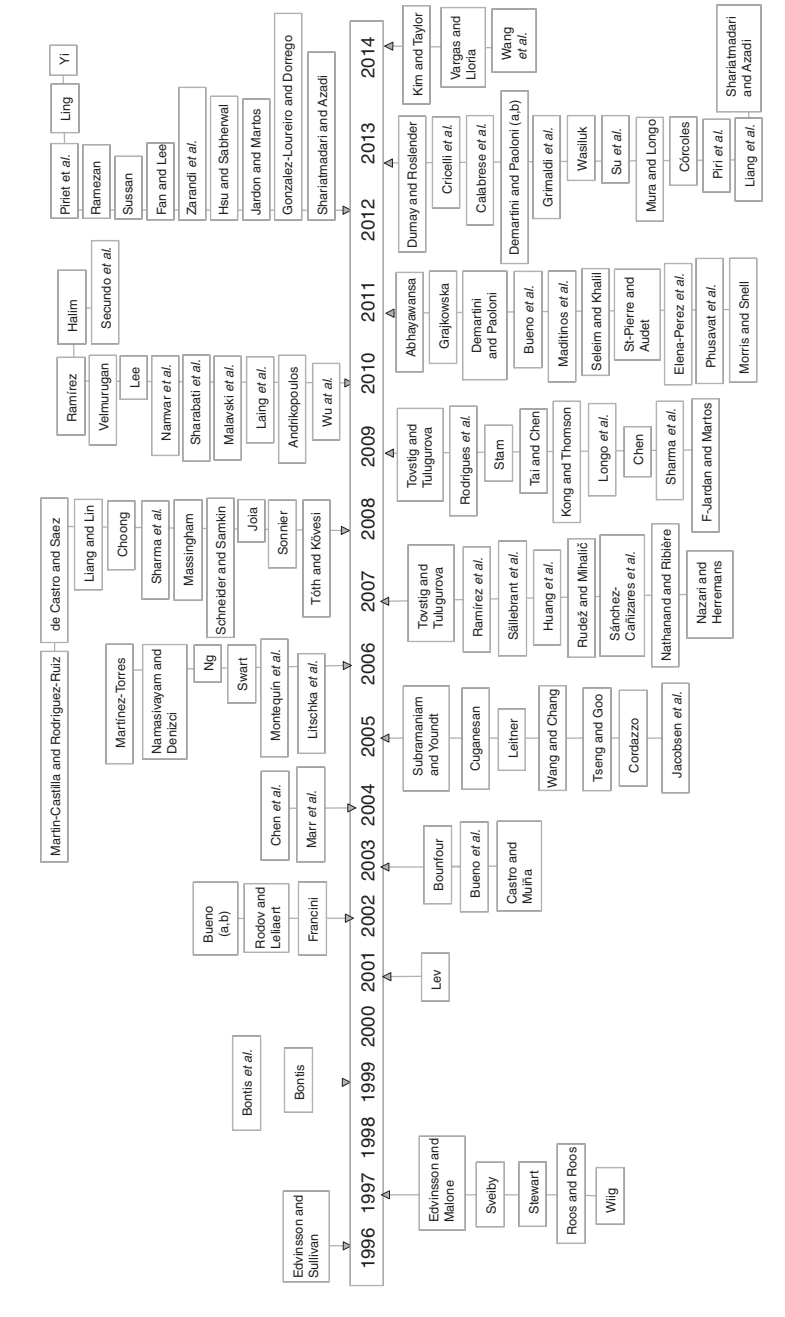

Figure 1.
Timeline of intellectual capital models

respective fields according to their conceptual level of appearance: first order, second order, third order or forth order. In the case that some dimensions could not be assigned to one of the 11 IC dimensions, they were assigned to a dimension as proposed in the paper analyzed. For example, Malavski *et al.* (2010) proposed at the second level (second order) the dimensions infrastructure assets and intellectual property. As both items do not fit the 11 IC dimensions, they were added to the dimension that best fit with the Malavski *et al.* explanations. Under the header labeled "analysis," some reflections relating to each IC model are presented. This also includes information about prior work the respective model is based upon. Indeed, as can be seen in Table II, several authors took advantage of prior work when presenting their own framework, whereas other authors used past research in order to highlight their way of looking at IC and its dimensions. The IC frameworks are presented in chronological order (i.e. year of publication).

After having presented the composition of the different IC models, in the following, the proposed frameworks are presented on a timeline (Figure 1).

As can be seen in Figure 1, the frameworks are displayed based on their year of publication. The intention was to make a visual display of the development of IC frameworks over time. As can be seen, some years are characterized by certain peaks, i.e. 2008, 2010, 2011, 2012 and 2013 indicating more research outcomes compared to other years. Figure 1 clearly shows that the study of IC frameworks still attracts research interest.

4. Presentation of IC Meta model

Having presented the IC frameworks in Table II, in a next step, and in order to better understand the IC dimensions proposed and discussed over time, the authors synthesized our current body of knowledge regarding IC and its dimensions in an IC Meta model (Figure 2).

The Meta model follows the same structure as presented in Table II and can be understood as follows. IC is considered the first-level construct and consists of the following second-order constructs: structural capital, human capital, relational capital and social capital. Structural capital is the "stuff" that is responsible for keeping the organization running (Marr, 2005). It covers tangible and intangible assets and is grounded by means of third-order constructs, e.g. innovation capital, process capital, technological capital and organizational capital. Human capital is considered the most important asset (Bontis, 2002). It is responsible for executing the other capitals. It is established by the following third-order constructs: motivation, interpersonal skills, knowledge, skills and attitudes. Eventually, relational capital embodies all the organization's relationships with customers, suppliers and other critical stakeholders (Roos *et al.*, 2001). Relational capital comprises the third-order constructs: customer capital and business capital. Social capital also addresses relationships, but in contrast to relational capital, it addresses the society as a whole (Still *et al.*, 2013). Social capital is determined by the third-order constructs social activities and social interactions.

5. Conclusion

This study aimed at reviewing the research on IC frameworks in order to get a better understanding of what has happened since Marr *et al.*'s work in 2004. Based on a systematic review of the literature, 83 additional IC models were identified. These frameworks were brought together with important works in the field, which were developed prior to 2004. The frameworks were analyzed regarding their IC dimensions

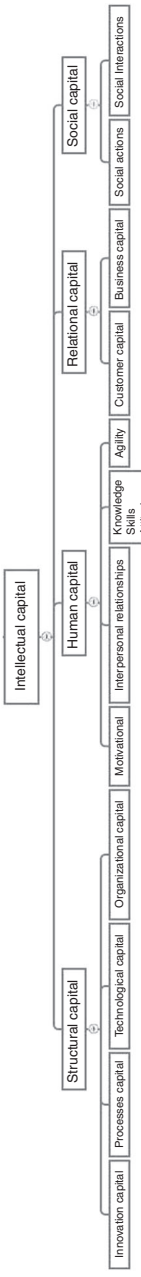

Figure 2.
A Meta model of IC

(Table II) and later mapped on a timeline (Figure 1). The timeline clarifies that 2008, 2010, 2011, 2012 and 2013 represent the years of greatest research activity (outcomes). The timeline also clarifies that beyond 2004, authors have shown continued interest in studying IC frameworks indicating a continued relevance of the topic. Table I also illustrates that the majority of researchers took advantage of previous research activities when coming up with their IC model. This is a welcome development as it prevents a state of permanent reinvention. Instead, greater efforts can be designed to the further development and refinement of the available IC dimensions. The analysis of the list of IC frameworks resulted in the development of an IC Meta model (Figure 2). This Meta model synthesizes previous research activities and highlights the main IC dimensions and sub-dimensions.

In conclusion, the study's findings make it possible to provide in-depth insights into the study of IC, its dimensions, and their development over time. As the field has significantly grown since Marr *et al.*'s work, the present study complements and extends their work. The present study also helps to illustrate whether a standardized perspective of IC has emerged. The findings suggest that IC is best approached through the dimensions human capital, structural capital, relational capital and social capital. Additionally, the findings provide information on how different authors understand and conceptualize IC dimensions. The resulting IC Meta model is considered the main contribution of this study. It provides a holistic view of the topic of IC classification/measurement and establishes our current body of knowledge regarding IC frameworks as published in peer-reviewed articles. This IC Meta model can serve as a useful basis for researchers interested in getting an overview of past activities. It can also inform further research activities in the field. The Meta model can also serve practitioners as they get a quick overview of IC and its dimensions. This in turn can simplify work on specific IC dimensions.

Having determined the IC dimensions is one side, we all know it is even more important to come up with ways or approaches that make the contribution of IC to value creation in organizations visible. In consideration of the work performed to date, which is summarized in the present paper's Meta model and also highlighted on the timeline, it is recommended that future research takes into consideration the rich material available and puts an even stronger focus on the development of IC measures. Thereby, the emphasis should not only be on making the contribution of individual IC dimensions visible, but on the combined and cumulative contribution of different IC dimensions (and tangible resources), as only this would reflect value creation in reality and the IC's contribution to company performance (Andriessen, 2004). At the same time, there is a need for future research activities that address the operationalization of the different third-order constructs. Even though different measures fort different constructs have been proposed over the years, the impression exists that the common feature of these measures is they are predominately based on information that is easy to collect in organizations and not on the information that would be needed to actually measure IC and its different constructs. If IC is really so important for organizations and their development, then increased efforts should be justified.

The authors are aware that the present study is not without limitations. Given the research process chosen, this study may not have allowed complete coverage of all contributions to the classification/measurement of IC. However, it seems reasonable to assume that the review process covered a large proportion of existing peer-reviewed articles. Finally, this paper proposes some research directions which are not exhaustive but represent initial ideas.

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