



Software Measurement Body of Knowledge – Overview of Empirical Support

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Agenda



- **Introduction**
- **Software Measurement topics in the SWEBOK**
 - ✓ Version 2001
 - ✓ Software Measurement KA: revised proposal (2004)
- **Analysis of Empirical Support for a new KA on Measurement**
 - ✓ The Baseline
 - ✓ A previous application in the SWEBOK Context (SwConstruction)
- **Empirical Support for the Software Measurement KA**
 - ✓ Premises
 - ✓ The Tables
 - ✓ Sources Classification & Ranking
- **Conclusions & Prospects**



Agenda

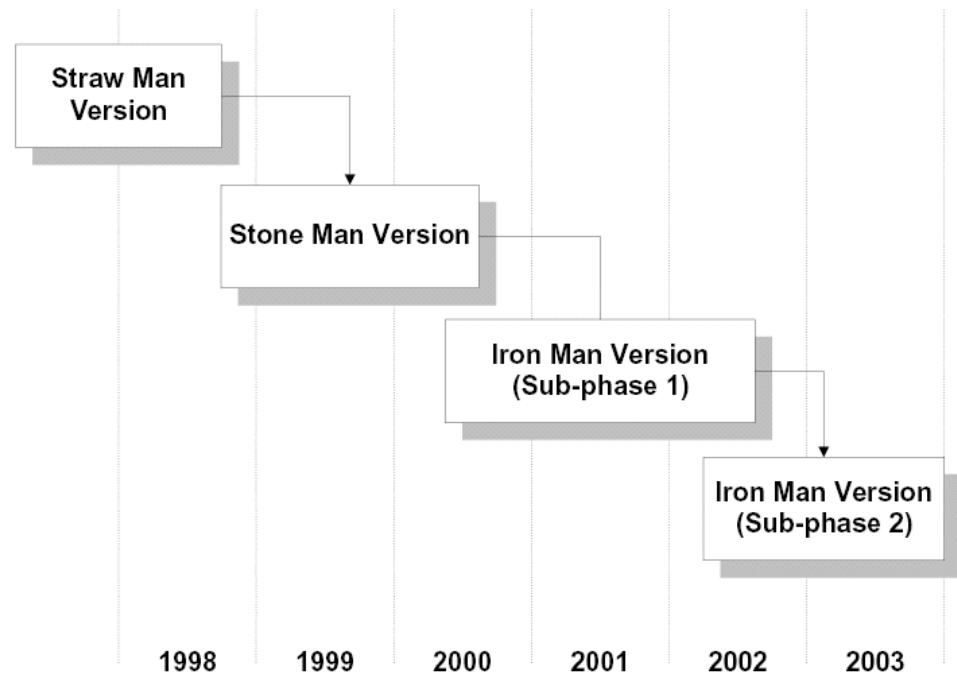


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Introduction

- One of the most relevant IEEE research projects of last years is without doubt the **Software Engineering Body of Knowledge (SWEBOK)**
- Its main goal is to develop a consensus on a guide to the “key knowledge” in the Software Engineering domain
- Its current version is the *Iron-Man* one, finalized during Y2004, freely available at www.swebok.org and www.computer.org
- Also recognized by IEEE-Computer Society and ISO as ISO/IEC TR 19579:2005





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Introduction

SWEBOK - Architecture (1)

The SWEBOK Guide contains 10 Knowledge Areas (KA) that can be easily mapped with the ISO/IEC 12207 processes

KA01 - Requirements	KA02 - Design	KA03 - Construction	KA04 - Testing	KA05 - Maintenance
KA06 - Software Configuration Management				
KA07 - Software Engineering Management				
KA08 - Software Engineering Process				
KA09 - Software Engineering Tools and Methods				
KA10 - Software Quality				

•Primary
Processes

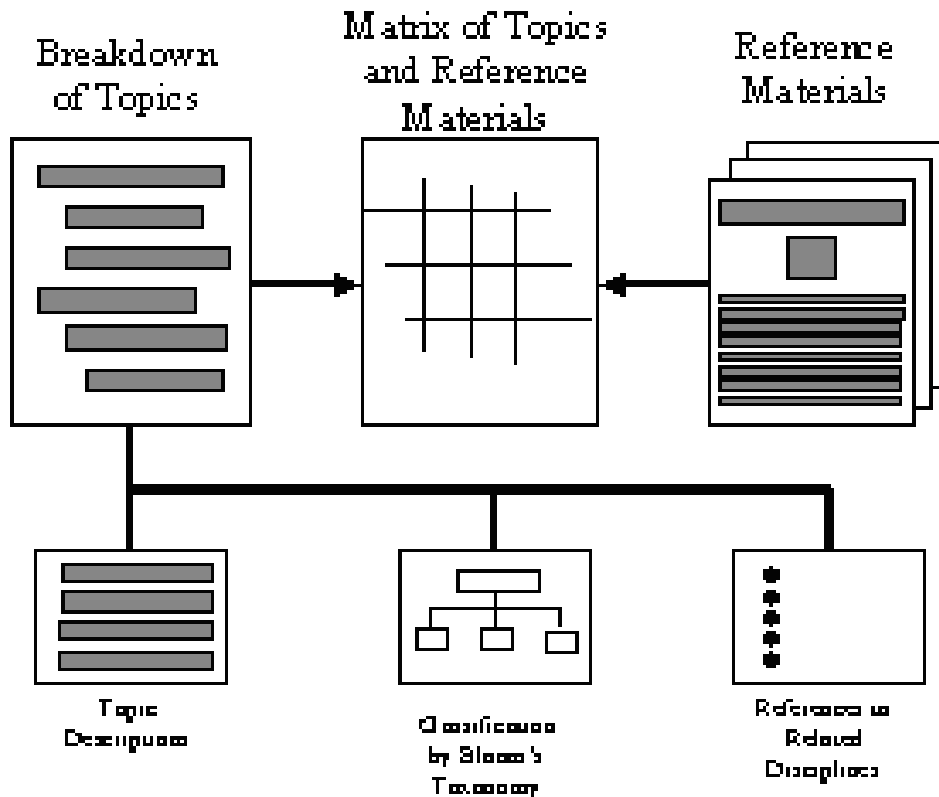
•Supporting
Processes



Introduction

SWEBOK - Architecture (1)

Each KA is represented according to a common hierarchical organization:



Introduction

SWEBOK – Common Themes

After describing the main (primary / supporting) processes as KA, three “cross” Common Themes run through the 10 KAs:

- *Quality*
- *Tools*
- *Measurement*

While Quality and Tools have also their own KA (KA.10 and KA.09):

- ✓ why did this not happen for the Measurement common theme?
- ✓ Measurement is pervasive throughout this Guide: is it right to leave Measurement as a Common Theme and not to recognize it as a separate Knowledge Area?



Agenda

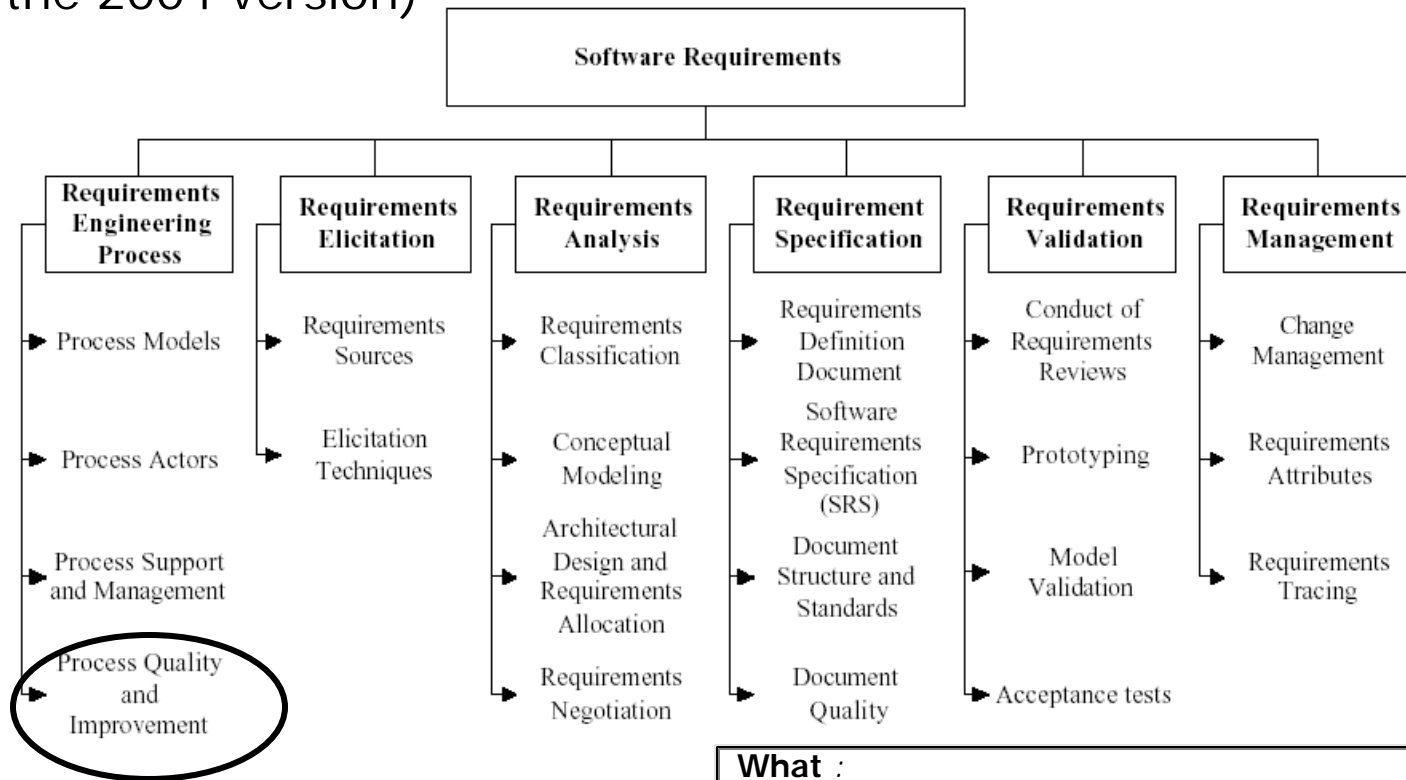


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Software Measurement topics in the SWEBOK Version 2001

In the 2001 version of the Guide, almost all KA had some measurement topics included (excepted the SwConstruction KA, with few additions in the 2004 version)



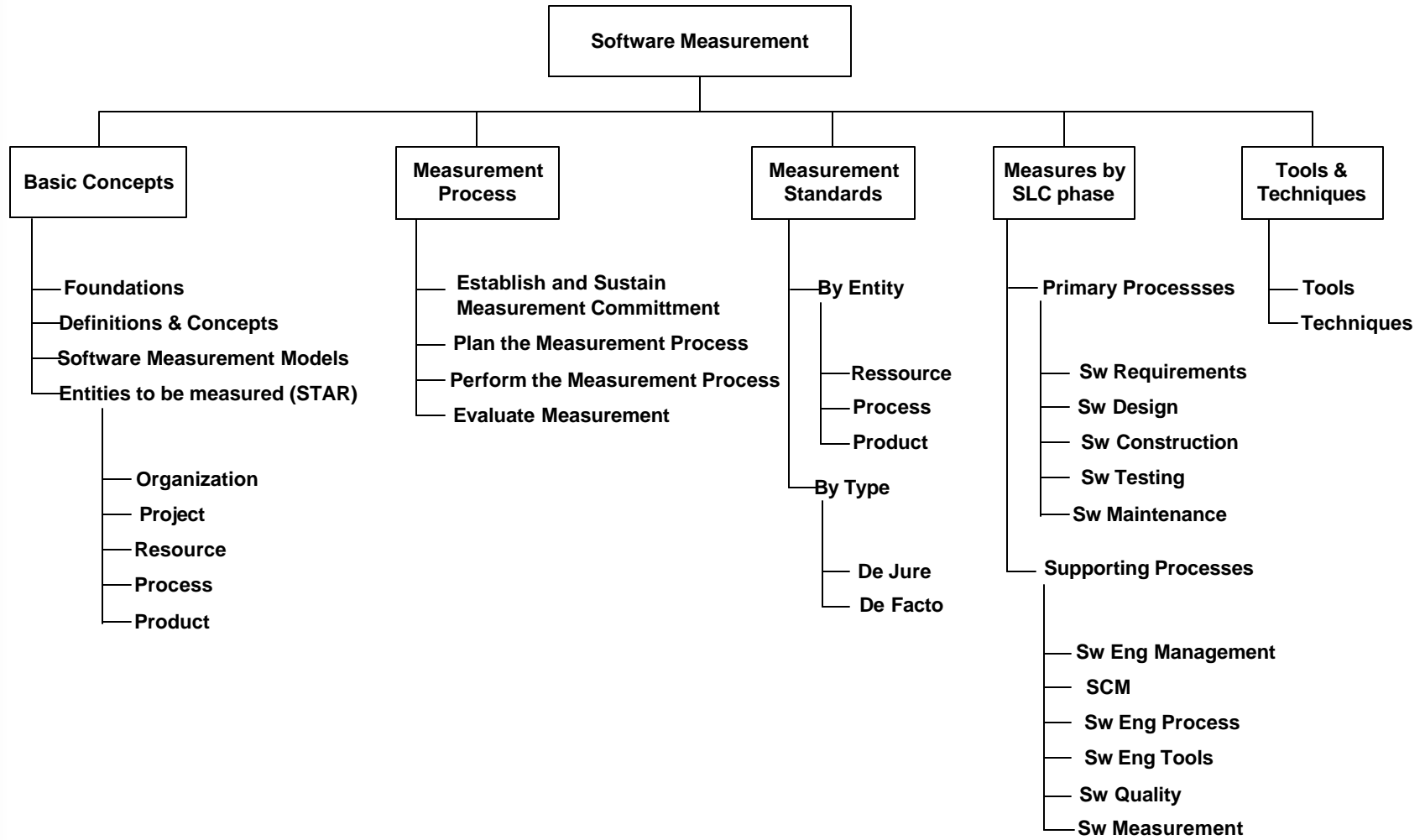
What :

- *Req.Eng Coverage by SPI std & models*
- *Req.Eng. Measures & benchmarking*
- *Improvement planning & implementation*



Software Measurement topics in the SWEBOOK

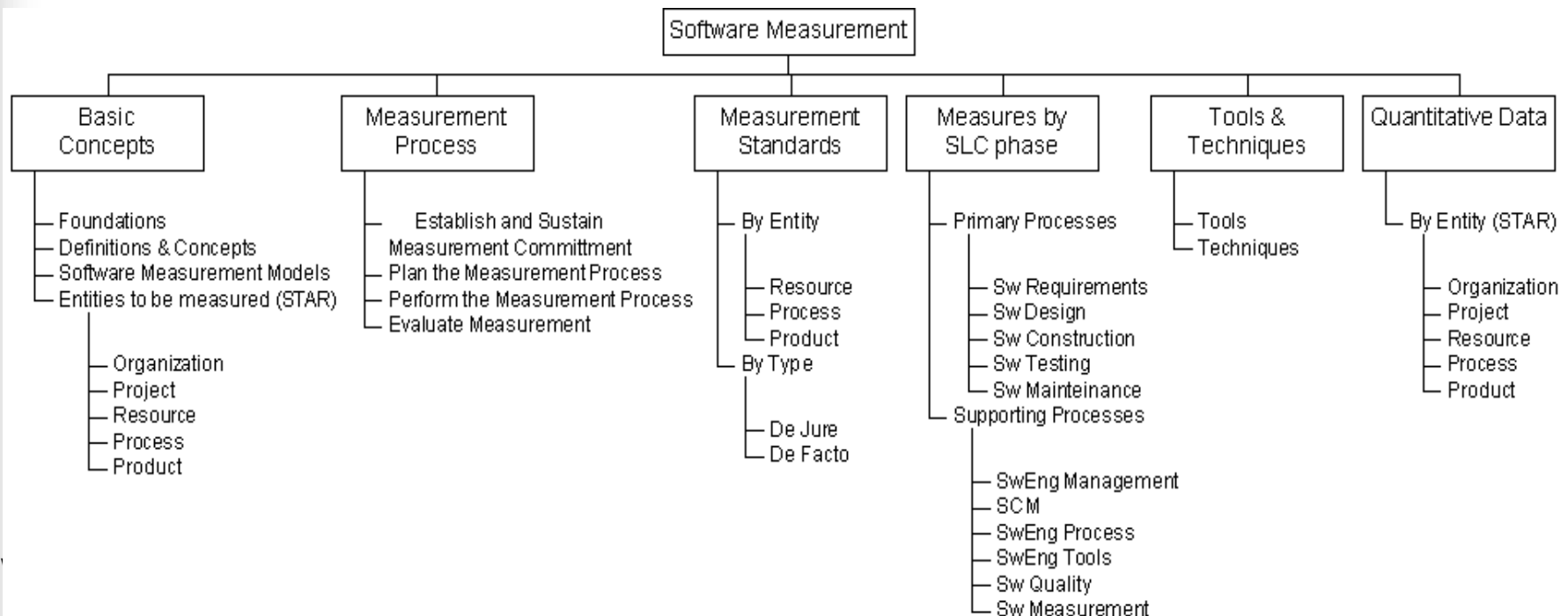
Version 2001 – Initial Proposal for a Software Measurement KA



Software Measurement topics in the SWEBOK

Software Measurement KA: Revised Proposal (2004)

- Using SWEBOK2004 measurement additions and Stone Man comments by reviewers, a further mapping against Shneidewind's Taxonomy to the proposed Software Measurement BoK was done
- Vincenti's classification was used to recognize and identify the types of engineering knowledge included in the software measurement KA
- From the gap analysis, we derived a new, revised and improved proposed breakdown for the Software Measurement KA



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Analysis of Empirical Support for a new KA

The Baseline

- **Objective:** to analyse the empirical support that this proposal of KA (with its sources) could bring to the SwEng community
- **Tool:** the Zelkowitz & Wallace taxonomy of empirical support methods

Category / Empirical support method	Description	Weaknesses	Strengths
A. Observational			
A1. Project Monitoring	Collect development data	No specific goals	Provides baseline for the future; inexpensive
A2. Case Study	Monitor project in depth	Poor controls for later replication	Can constrain one factor at low cost
A3. Assertion	Use ad-hoc validation technique	Insufficient validation	Serves as a basis for future experiments
A4. Field Study	Monitor multiple projects	Treatments differ across projects	Inexpensive form of replication
B. Historical			
B1. Literature Search	Examine previous published studies	Selection bias; treatments differ	Large available database; inexpensive
B2. Legacy	Examine data from completed projects	Cannot constrain factors; data limited	Combines multiple studies; inexpensive
B3. Lessons Learned	Examine qualitative data from completed projects	No quantitative data: cannot constrain factors	Determine trends; inexpensive
B4. Static Analysis	Examine structure of developed product	Not related to development method	Can be automated; applies to tools
C. Controlled			
C1. Replicated	Develop multiple versions of product	Very expensive; Hawthorne effect	Can control factors for all treatments
C2. Synthetic	Replicate one factor in lab setting	Scaling up; interactions among multiple factors	Can control individual factors; moderate cost
C3. Dynamic Analysis	Execute developed product for performance	Not related to development method	Can be automated; applies to tools
C4. Simulation	Execute product with artificial data	Data may not represent reality; Not related to development method	Can be automated; applies to tools; evaluation in safe environment

Analysis of Empirical Support for a new KA

A previous application in the SWEBOK Context (SwConstruction)

- **Objective:** identify some weaknesses and provide further guidance on content improvements

Knowledge Topics	Method Used	
2.0. Definition		
2.1. Software Construction and Software Design	A3	Assertion
2.2. The role of tools in construction	A4	Field Studies
2.3. The role of integrated evaluation in construction	A3	Assertion
2.4. The role of standards in construction	---	N/A
2.5. Manual and automated construction	A3	Assertion
2.6. Construction Languages	A3	Assertion
2.7. Programming Languages	---	N/A
3.0. Breakdown		
3.1. Principle of organization		
3.1.1. Reduction in Complexity	A4	Field Studies
3.1.2. Anticipation of Diversity	A3	Assertion
3.1.3. Structuring for Validation	A2	Case Studies
3.1.4. Use of External Standards	---	N/A
3.2. Style of Construction		
3.2.1. Linguistic	---	N/A
3.2.2. Formal	---	N/A
3.2.3. Visual	---	N/A

Source: Suryn W., Robert F., Abran A., Bourque P. & Champagne R., Experimental Support Analysis of the Software Construction Knowledge Area in the SWEBOK Guide (Trial Version 1.0), Proceedings of the 10th International Workshop on Software Technology and Engineering Practice (STEP2002), 6-8 October 2002, Montréal (Canada), URL: <http://www.irg.ugam.ca/publications/pdf/764.pdf>



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Empirical Support for the Sw Measurement KA Premises

- SWEBOK2004 references were mapped against the 2004 SwMeasurement breakdown proposal
- Subdivisions of sources into:
 - **International Standards**: from ISO, IEEE or other Standards Organization, based on international consensus → Not Rated
 - **Books**: they often represent only authors' opinion; they contain several chapters, each one could be based on a different type(s) of empirical support → Not Rated
 - **Papers & Books Chapters**: for these ones, the most relevant empirical support method is mentioned
- Addition of a first set of new references where references were missing (in bold)



Empirical Support for the Sw Measurement KA

The Tables (1/5)

SWEBOK Measurement Topics Breakdown	Source / Item	International Standards	Books	Papers & Book chapters: Empirical Method Used
1.0. Basic Concepts	New			
1.1. Foundations	SEP, §8.4.3	[ISO93]	[Zus97] [Shep95]	[Abr03]: Legacy (B2)
1.2. Definitions and concepts	SEP, §8.4.3 SEM, §7.6	[ISO15939-02] [ISO93]	[Kan02]	[Abr96]: Legacy (B2) [Fen98: c2]: Literature Search (B1) [Pfi01: c11]: Literature search (B1) [Abr02]: Literature Search (B1)
1.3. Software Measurement Models	SEM, §7.2.6	[ISO15939-02]		
1.4. Entities to be measured (STAR)	New			[Bug02]: Literature search (B1)
1.4.1. Organization				---
1.4.2. Project				---
1.4.1. Resource				---
1.4.1. Process				---
1.4.1. Product				---
2.0. Measurement Process				[Jac97]: Static Analysis (B4)
2.1. Establish and Sustain Measurement Commitment	SEM, §2.6.1	[ISO15939-02]	[PSM03]	[Fen98: c3,c13]: Literature Search (B1) [Pre04: c22]: Literature Search (B1)
2.2. Plan the Measurement Process	SEM, §2.6.2	[ISO15939-02]	[PSM03]	
2.3. Perform the Measurement Process	SEM, §2.6.3	[ISO15939-02]	[PSM03]	
2.4. Evaluate Measurement	SEM, §2.6.4	[ISO15939-02]	[PSM03]	



Empirical Support for the Sw Measurement KA

The Tables (2/5)

SWEBOK Measurement Topics Breakdown	Source / Item	International Standards	Books	Papers & Book chapters: Empirical Method Used
3.0. Measurement Standards	New			
3.1. By Entity				
3.1.1. Resource		[IEEE830-98]		
3.1.2. Process	SEP, App.B	[ISO15939-02] [IEEE1219-98] [IEEE12207.0-96] [ISO15288-02] [ISO95] [IEEE1045-92]		
3.1.3. Product	SEP, §8.4.2 SEP, App.B	[ISO9126-01] [IEEE14143.1-00] [ISO19761-03] [ISO20926-03] [ISO20968-02] [ISO14598] [ISO9241] [ISO24570] [IEEE1061-98]	[Jon96]	
3.2. By Type				
3.2.1. De Jure	All the IEEE/ISO std on SwMeas previously listed in Section 3.1			
3.2.2. De Facto	GQM		[PSM03] [Sol99]	[Bas94]: Assertion (A3)



Empirical Support for the Sw Measurement KA

The Tables (3/5)

SWEBOK Measurement Topics Breakdown	Source / Item	International Standards	Books	Papers & Book chapters: Empirical Method Used
4.0. Measures by SLC phase				
4.1. Primary Processes				
4.1.1. Software Requirements	SR, §1.7.5	[IEEE14143.1-00] [ISO19761-03] [ISO20926-03] [ISO20968-02]		
4.1.2. Software Design	SD, §2.4.3			[Jal97: c5,c6,c7] : Literature search (B1) [Pre04: c15]: Literature Search (B1)
4.1.3. Software Construction	SC, §3.2.3		[McC04]	[McCA76] : Static Analysis (B4)
4.1.4. Software Testing	ST, §4.4.1.1 ST, §4.4.1.3 ST, §4.4.1.4 ST, §4.4.1.5 ST, §4.4.2.1 ST, §4.4.2.2 ST, §4.4.2.3 ST, §4.5.1.6 ST, §4.5.1.7			[Bei90:c7s4.2] : Literature search (B1) [Jor02:c9] : Literature search (B1) [Per95:c20] : Literature search (B1) [Pfi01:c9] : Literature search (B1) [Lyu96:c7] : Literature search (B1) [Pfi01:c9] : Literature search (B1) [Jor02:c9] : Literature search (B1) [Pfi01:c8] : Literature search (B1) [Pfi01:c8] : Literature search (B1) [Zhu97:s3.2-s3.3]: Literat. Search (B1) [Per95:c4,c21] : Literature search (B1) [Bei90:c2s2.4] : Literature search (B1) [Per95:c2] : Literature search (B1)
4.1.5. Software Maintenance	SM, §5.2.4.1	[IEEE1219-98:Tab3] [IEEE1219-98] [ISO9126-01] [ISO19761-03]		[Abr93]: Case Study (A3) [Car90:s2-s3] : Literature search (B1) [Sta94: 239-249]: Field Study (A4)



Empirical Support for the Sw Measurement KA

The Tables (4/5)

SWEBOK Measurement Topics Breakdown	Source / Item	International Standards	Books	Papers & Book chapters: Empirical Method Used
4.2. Supporting Processes				
4.2.1. Software Engineering Management	SEM, §7.6.4	[ISO15939-02: s5.4.1, s5.4.2 +App.D]		[Stri00] : Legacy (B2)
4.2.2. Software Configuration Management	SCM, §6.1.5.1			[Buc96: c3] : Literature search (B1) [Roy98: 188-202, 283-298]
4.2.3. Software Engineering Process	SEP, §8.4.1	[ISO15939-02]		[Fen98: c3,c11]: Literature Search (B1) [Som05: c25] : Literature search (B1)
4.2.4. Software Engineering Tools	New			
4.2.5. Software Quality	SQ, §10.3.4		[Gra92] [Fen97] [Jon96] [Kan02] [Lyu96] [Mus99] [Pfi01]	[Rak97: pp39-50]: Literature Search (B1)
4.2.6. Software Measurement	SEM, §7.6.4	[ISO15939-02: s5.4.1 +App.D]		



Empirical Support for the Sw Measurement KA

The Tables (5/5)

SWEBOK Measurement Topics Breakdown	Source / Item	International Standards	Books	Papers & Book chapters: Empirical Method Used
5.0. Tools & Techniques				
5.1. Tools	SETM, §9.1.7		[Dor02]	
5.2. Techniques	SEP, §8.4.5 SEP, §8.4.5.1 SEP, §8.4.5.2	[IEEE12207.0-96]	[Gol99] [Fen98] [SEL96] [Mus99] [Hum95]	
6.0. Quantitative Data	New			
6.1. By Entity (STAR)				
6.1. Organization	Appraisal CMMI, Sw-CMM, SPICE, ... Performance Mgmt Models (MBQA, EFQM, BSC, ...)			[SEMA04a] : Field Study (A4) [SEMA04b] : Field Study (A4)
6.2. Project	Benchmark ISBSG r9			[ISBSG04] : Field Study (A4)
6.3. Resource	P-CMM, ...			[PCMM-01] : Literature Search (B1)
6.4. Process	Appraisal CMMI, Sw-CMM, SPICE, ...			[SEMA04a] : Field Study (A4) [SEMA04b] : Field Study (A4)
6.5. Product	ISO/IEC 9126 profiles, ...			[Fra03] : Literature Search (B1)



Empirical Support for the Sw Measurement KA Sources Classification & Ranking

	Abs	%	Rank
N.A. – Standards	9	37.5	1
N.A. – Books	4	16.7	2
A4. Field Study	3	12.5	3
B2. Legacy	3	12.5	3
B1. Literature Search	2	8.3	5
B4. Static Analysis	2	8.3	5
A3. Assertion	1	4.2	7
C4. Simulation	0	0.0	8
A1. Project Monitoring	0	0.0	8
A2. Case Study	0	0.0	8
B3. Lessons Learned	0	0.0	8
C1. Replicated	0	0.0	8
C2. Synthetic	0	0.0	8
C3. Dynamic Analysis	0	0.0	8
	24	100.0	

- This ranking for additional references could be a starting point for filling the gaps
- A large amount of sources comes from standards and entire books, with few references from technical papers, reports, manuals and books chapters



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Conclusions & Prospects

- IEEE project for SWEBOK was started in 1998, with the purpose to *“provide a consensually validated characterization of the bounds of the software engineering discipline and to provide a topical access to the Body of Knowledge supporting that discipline”*
- It contains 10 Knowledge Areas (KA) and 3 common themes, one of these is Measurement, but right now it has not been recognized as a distinct KA
- In 2003 a project for a new, devoted KA on Software Measurement was started, based on the SWEBOK2001 version and updated during 2004 using mappings against Schneidewind BoK and Vincenti’s classification of Engineering types.
- A new step towards the final proposal is the evaluation of measurement-related references from the SWEBOK2004 version, using the Zelkowitz & Wallace taxonomy of empirical support methods
- A large number of references are standards or books, with few papers, reports and guides.
- The analysis of these results will be the starting point for *“filling the gaps”*, according to the *“generally accepted”* principle with validation by peers in the Software Measurement community



Q & A



Thank you!



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