



Hochschule Kempten  
University of Applied Sciences

# **Requirement Engineering for Knowledge-Intensive Processes**

**– Development of a Reference Architecture for the  
Selection of a Learning Management System –**

Figures

By: Dipl.-Ing. (Univ.) Sven-M. Wundenberg

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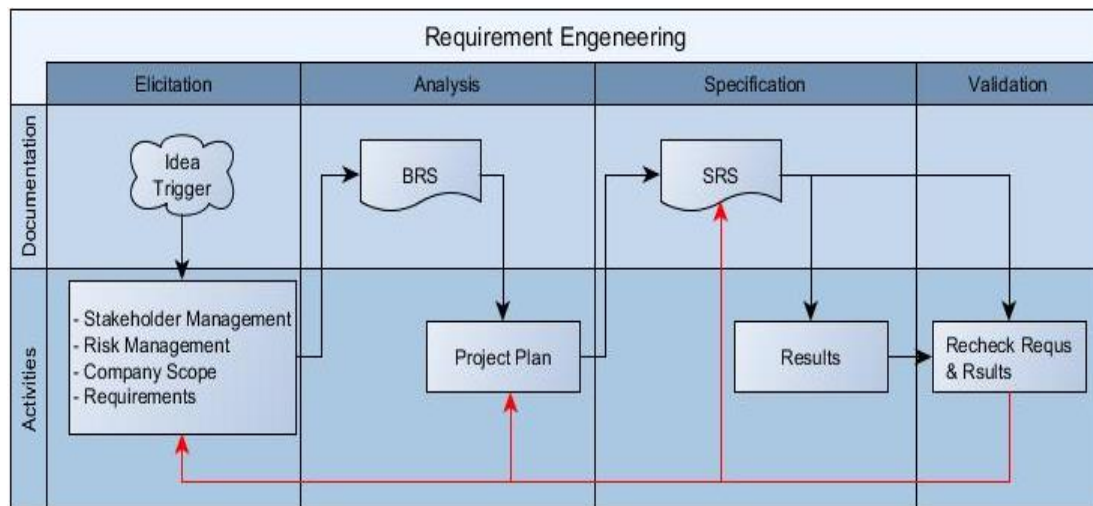


Figure 1: RE Process Model

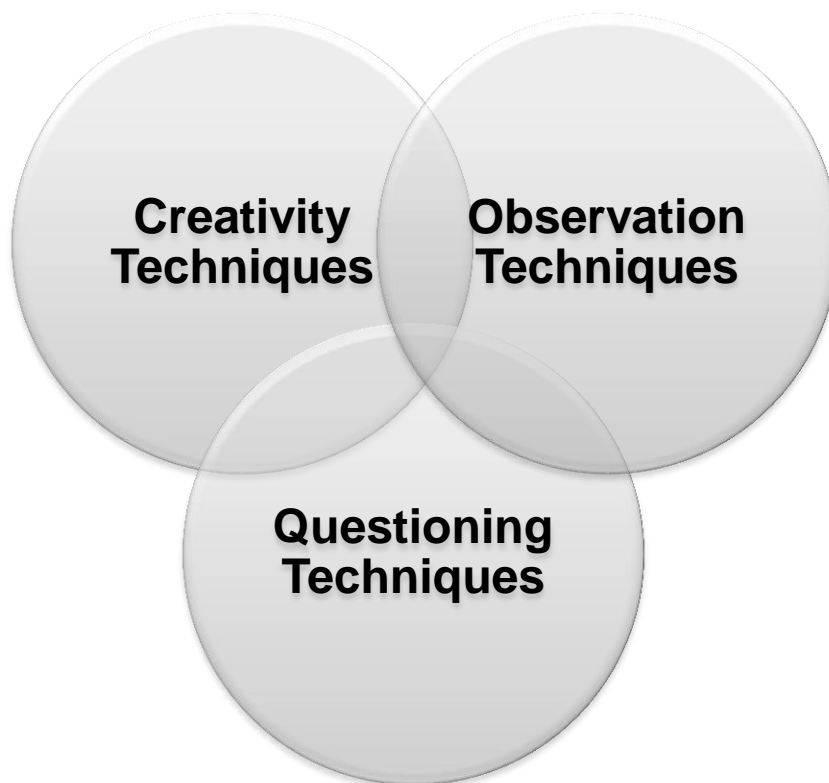


Figure 2: Requirement Elicitation Techniques

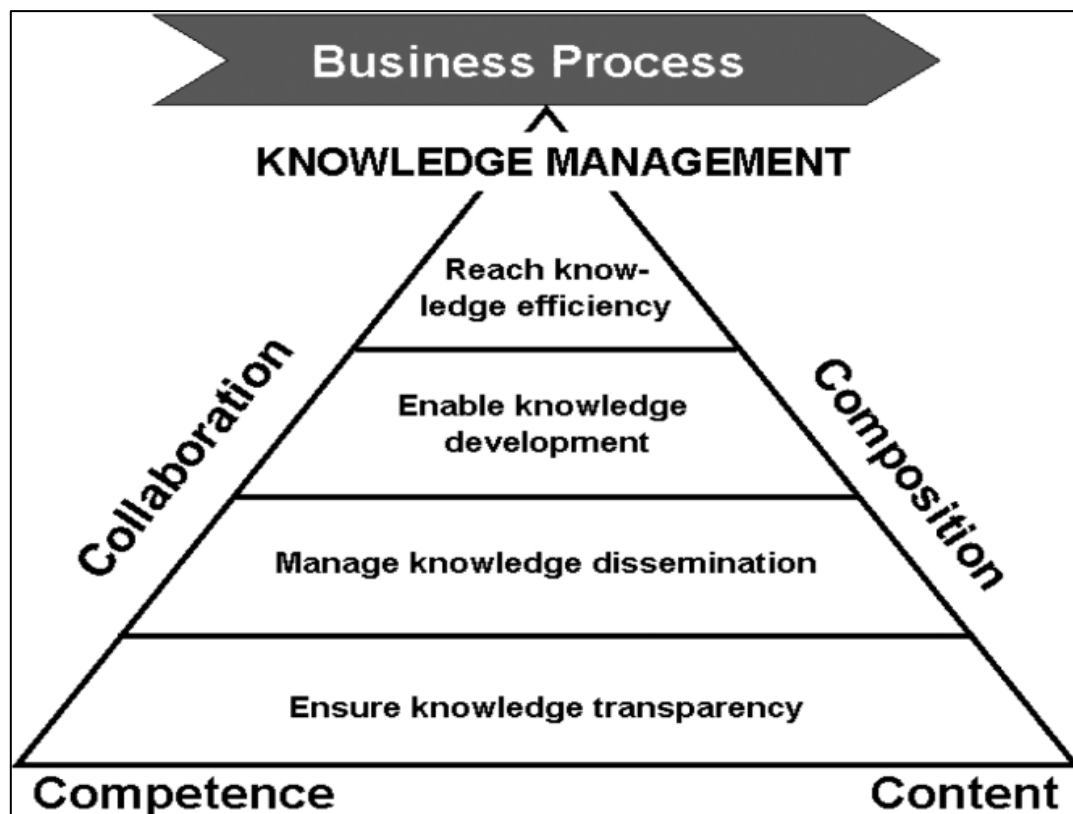


Figure 3: KM Layers and Areas (CEN, 2004)

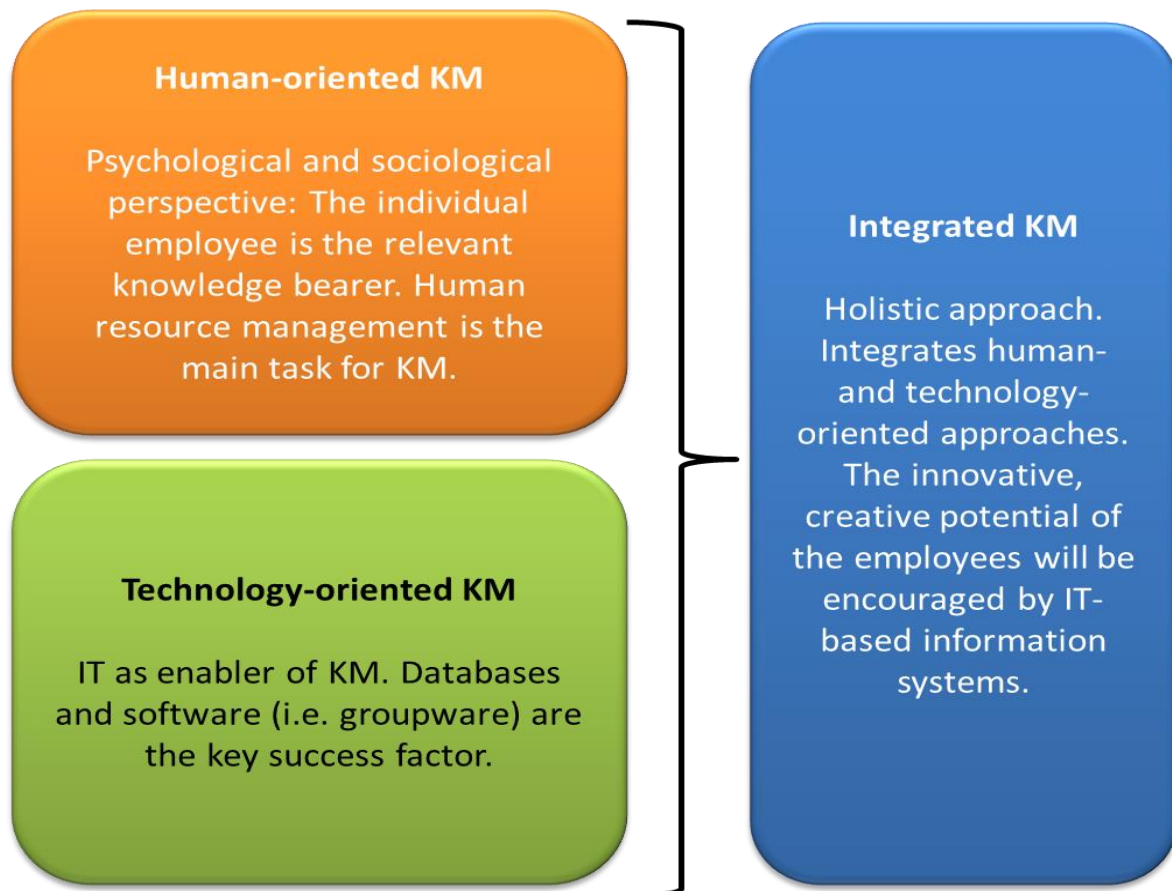


Figure 4: KM Definition

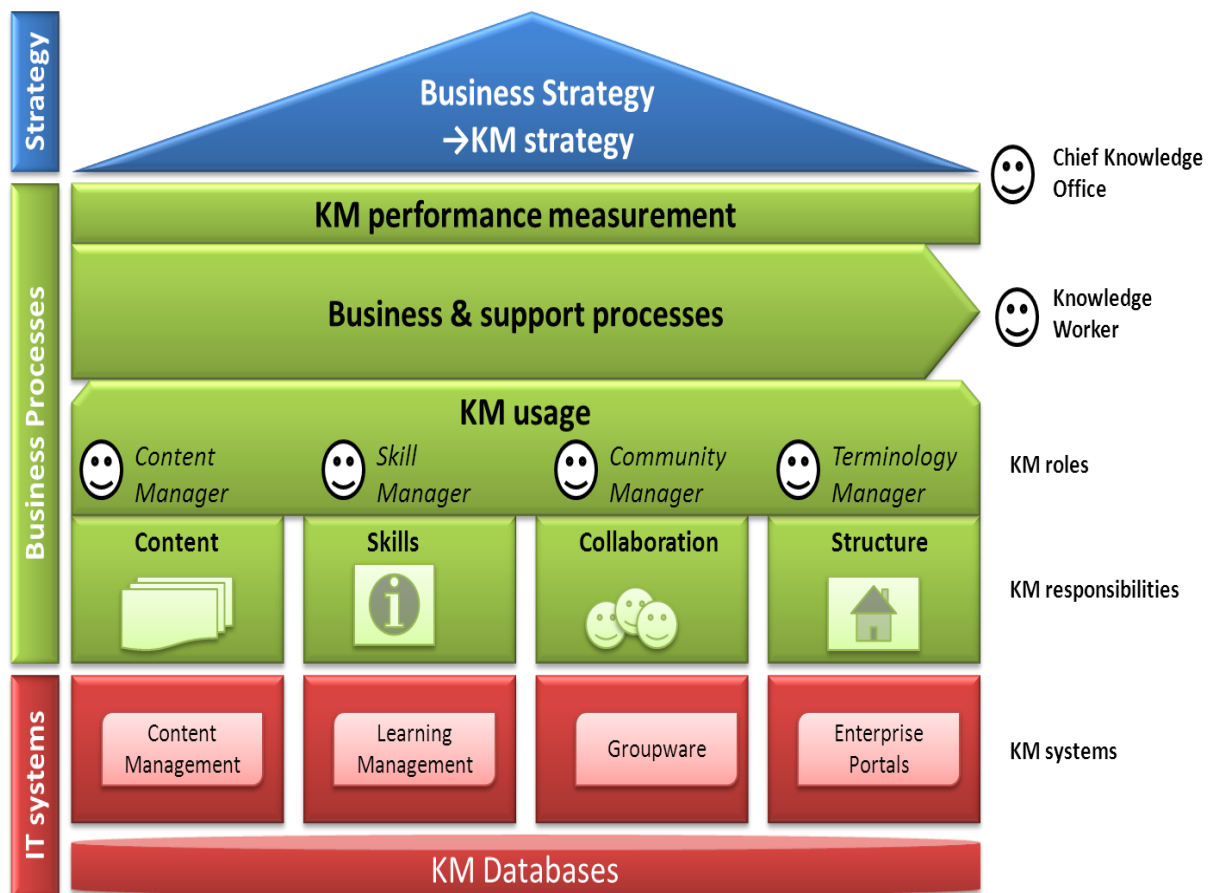


Figure 5: Architecture for an integrated KMS (Riempp, 2003)

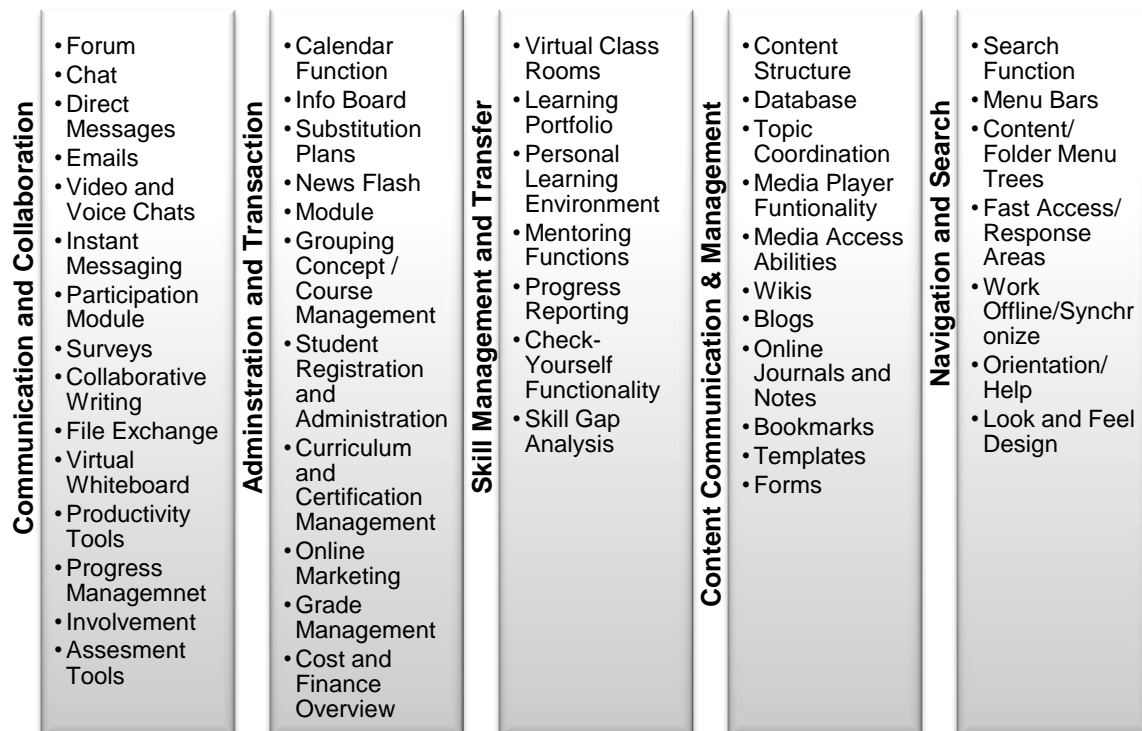


Figure 6: Common LMS Features

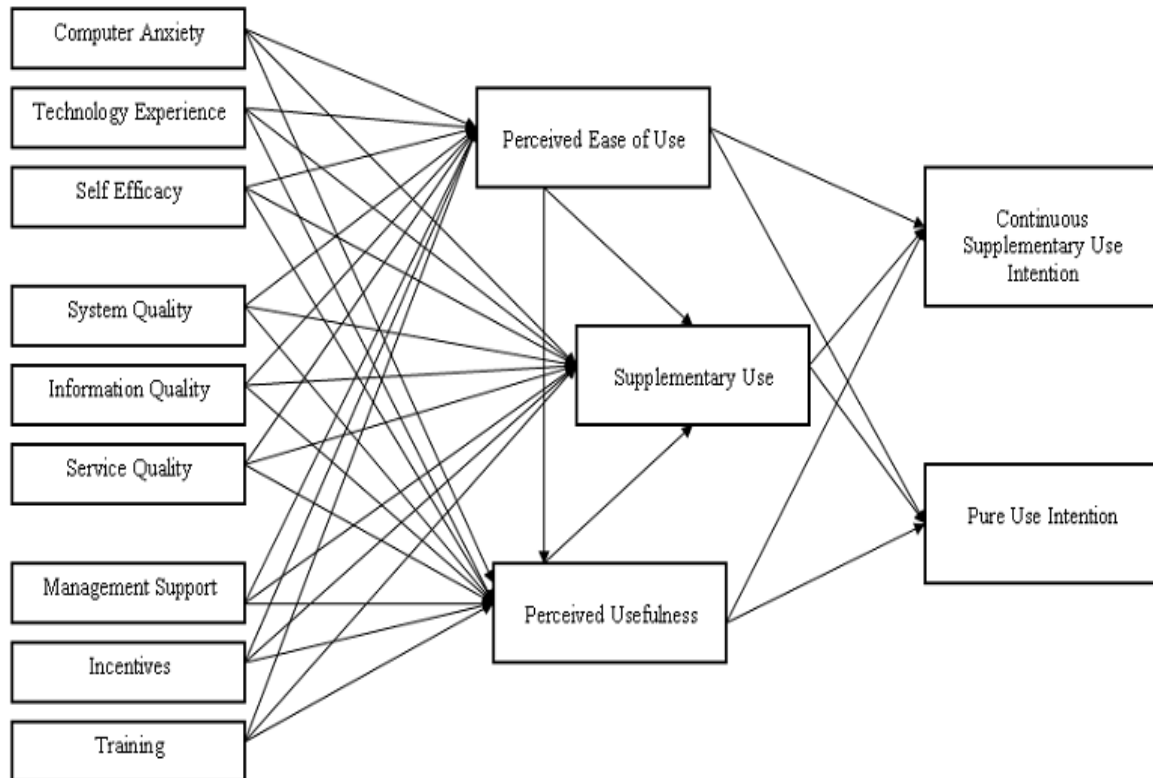


Figure 7: Critical Factors for LMS Acceptance (Al-Busaidi & Al-Shihi, 2012)

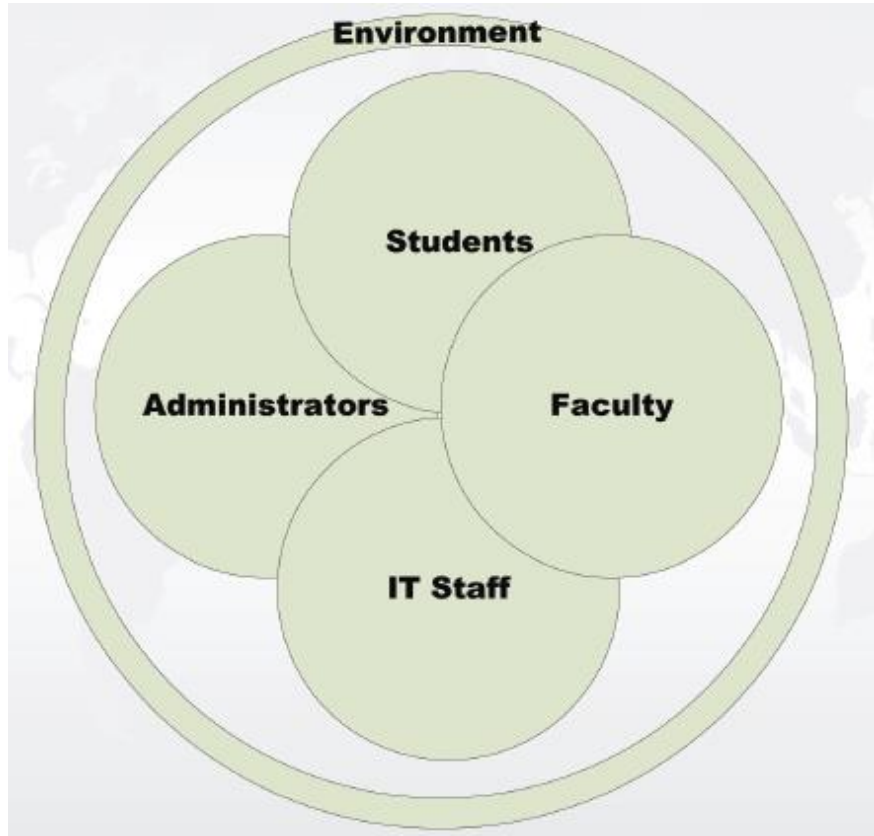


Figure 8: Stakeholder Arrangement (Folden, 2011)

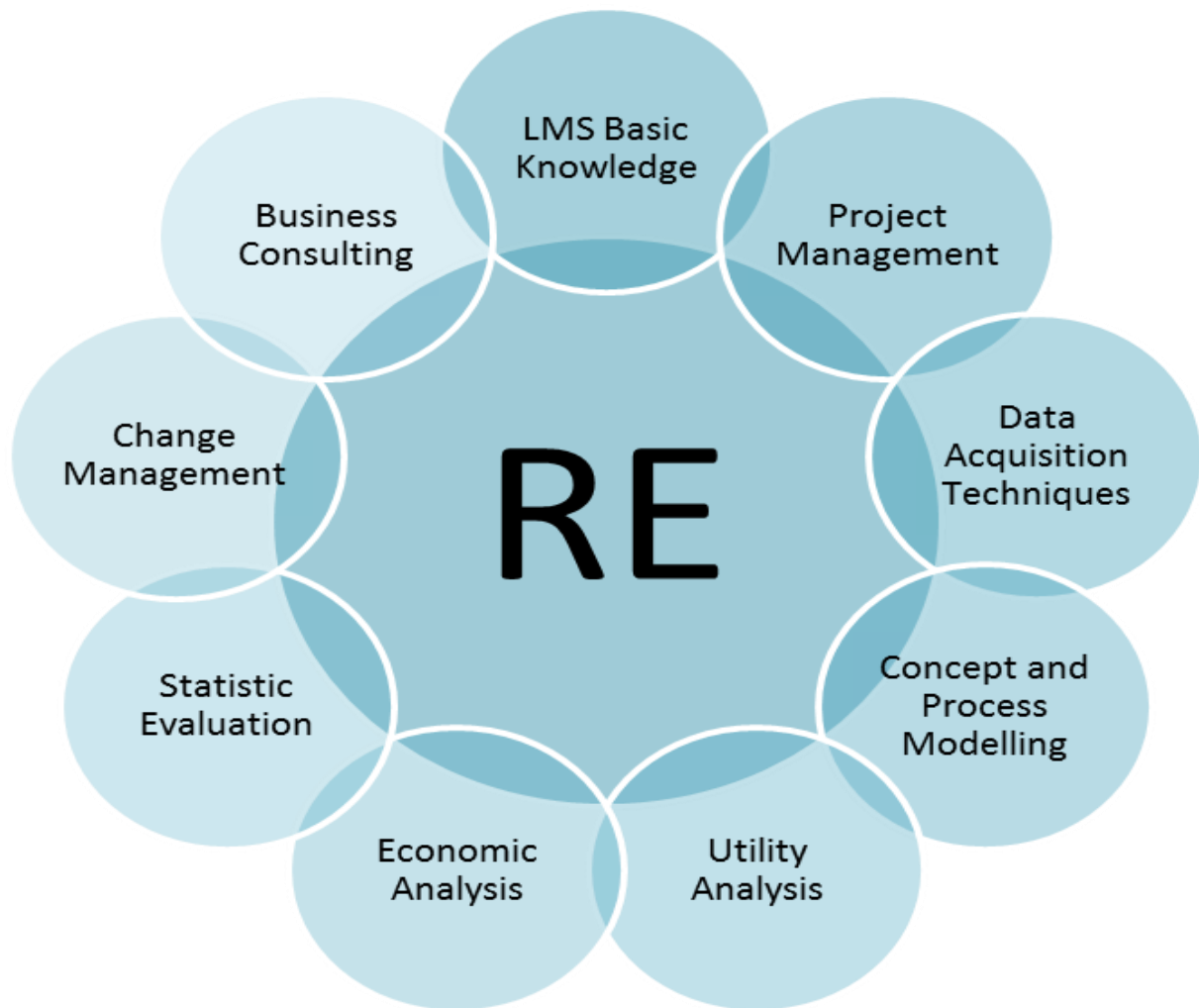


Figure 9: Problem Domain



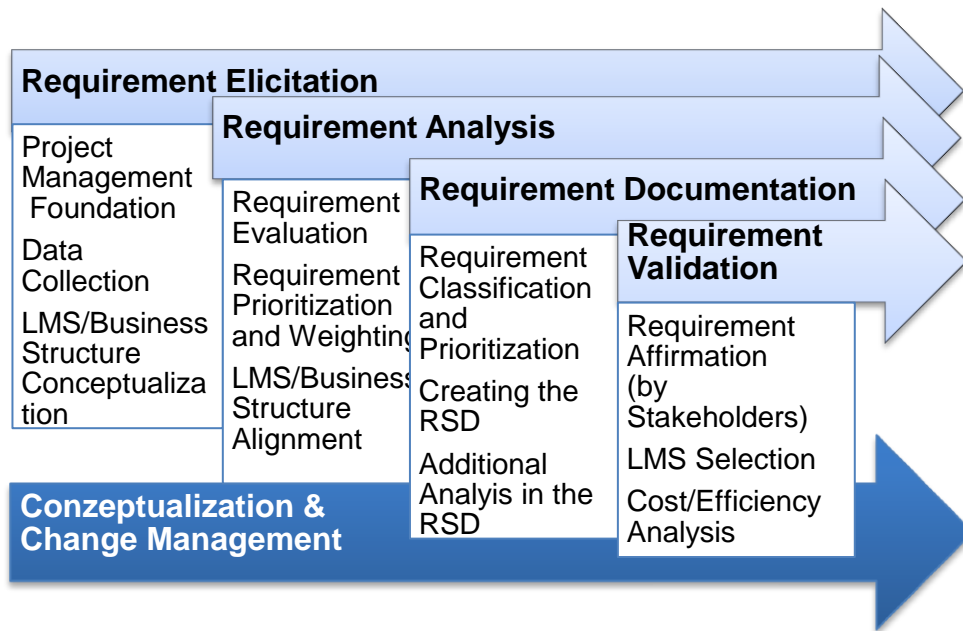


Figure 10: RefArc Steps aligned to RE structure

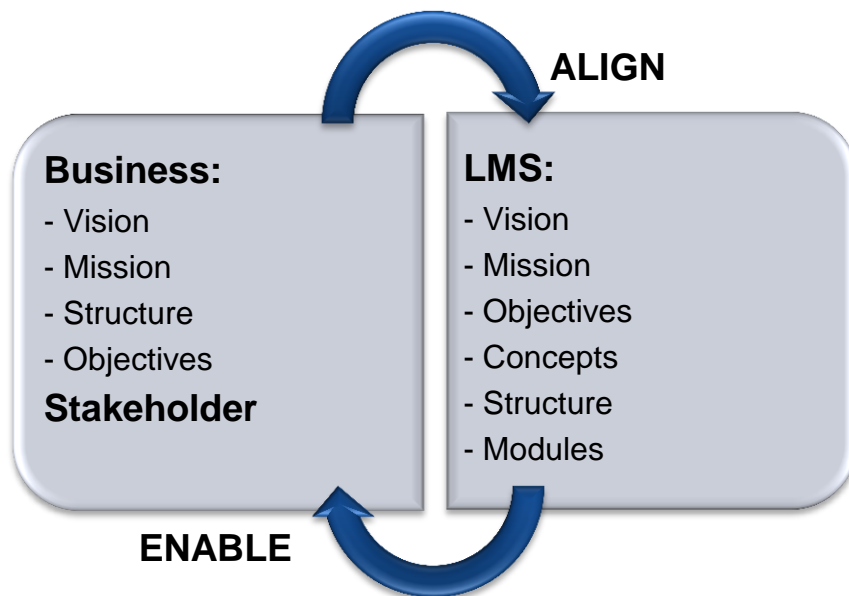


Figure 11: Business/LMS Relation (Frankfurth, 2010)

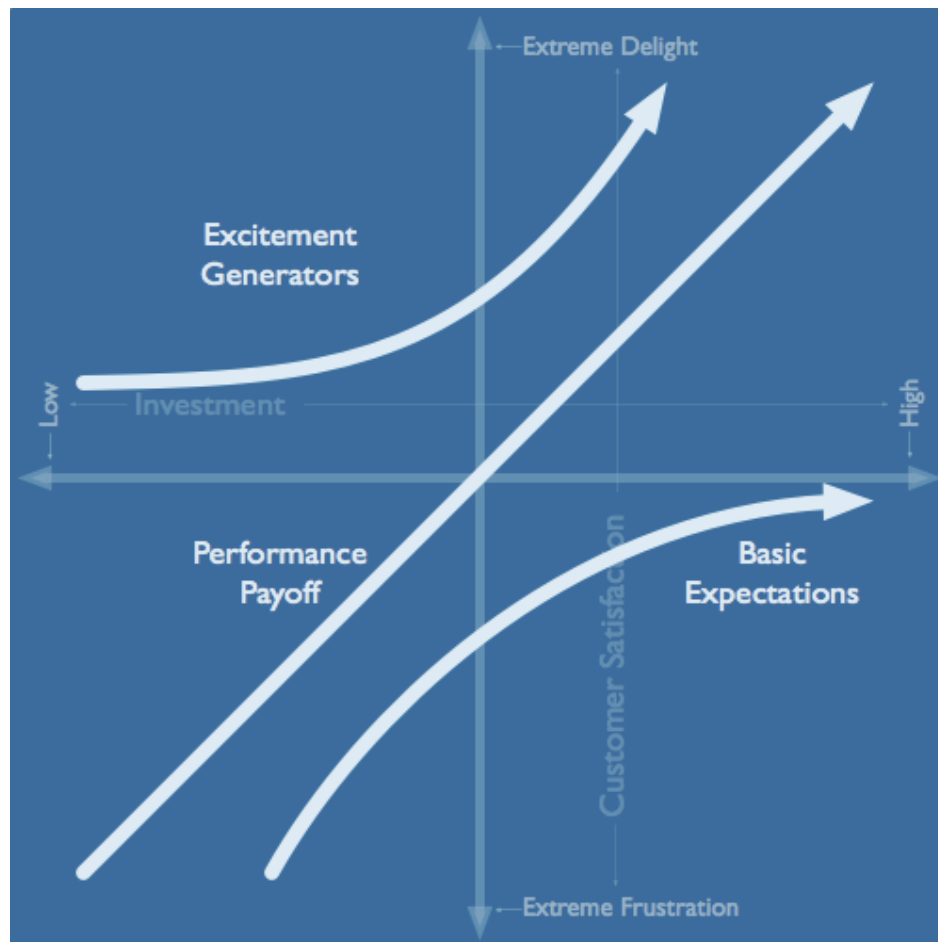


Figure 12: "Kano-Model" (Spool, 2011)

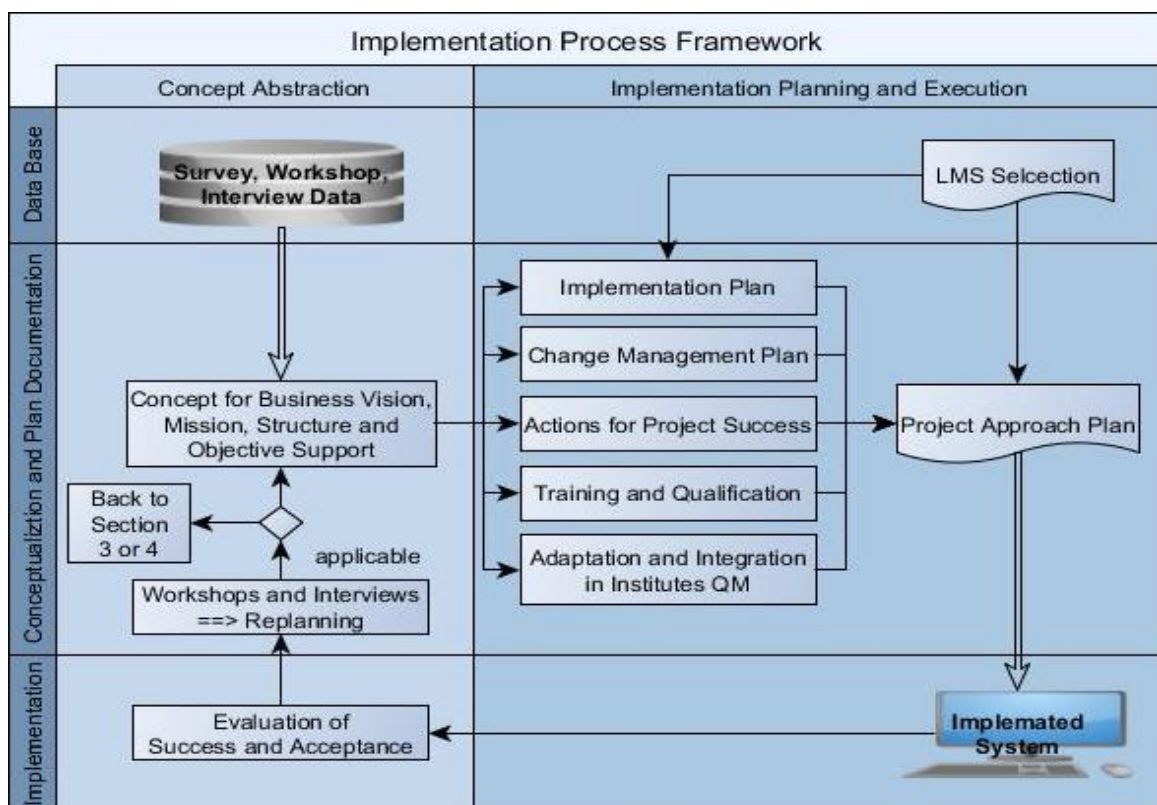


Figure 13: Implementation Process Framework

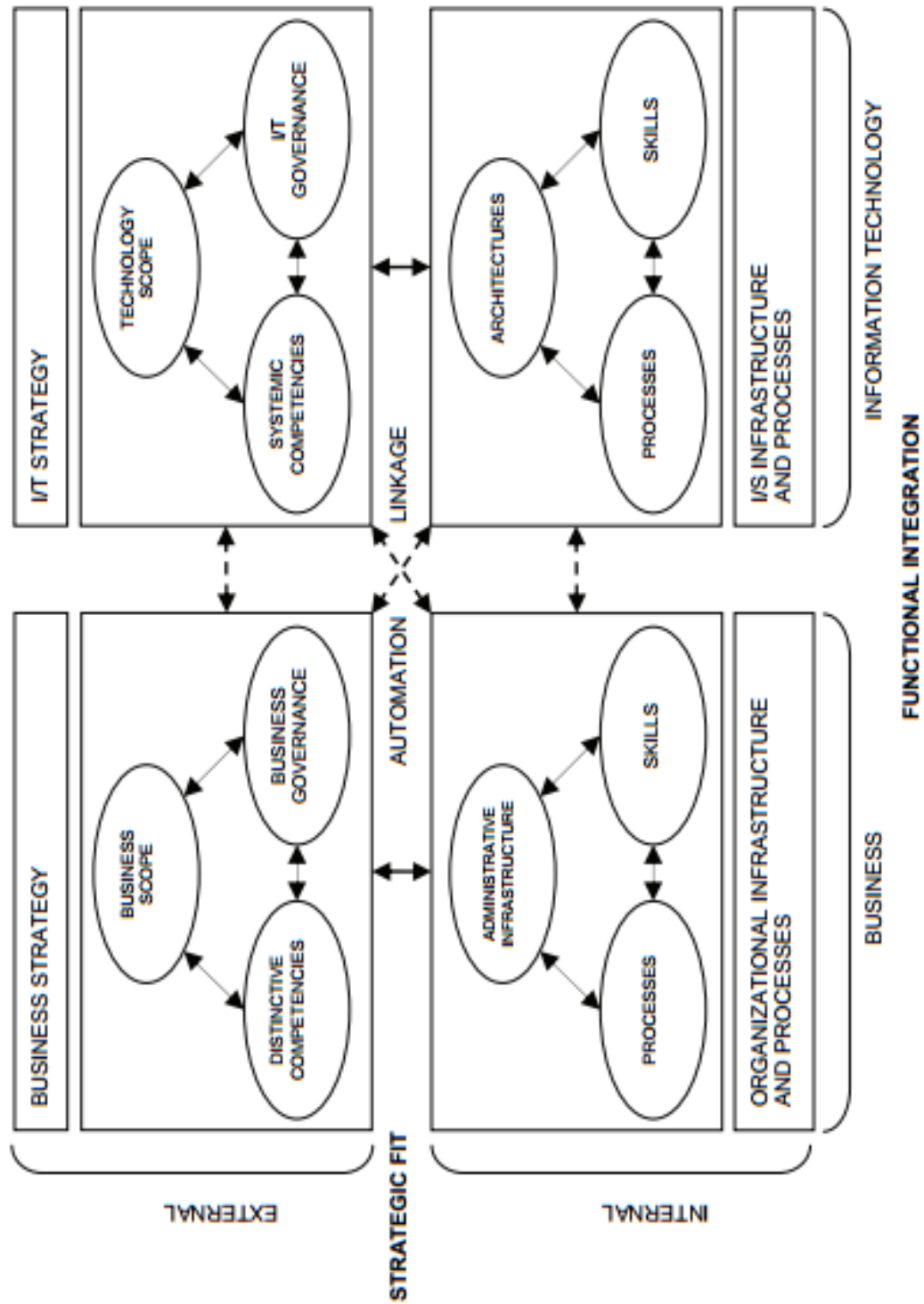


Figure 14: Strategic Alignment Model (Henderson & Venkatraman, 1993)

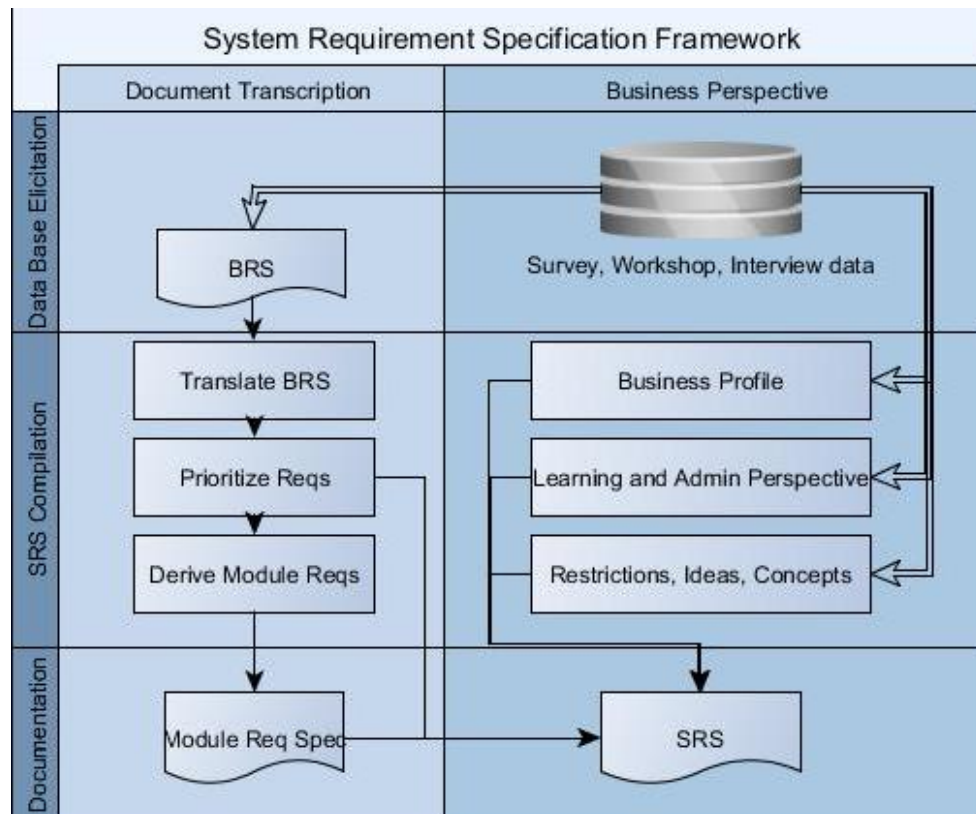


Figure 15: Process Model – Creating the RSD/SRS

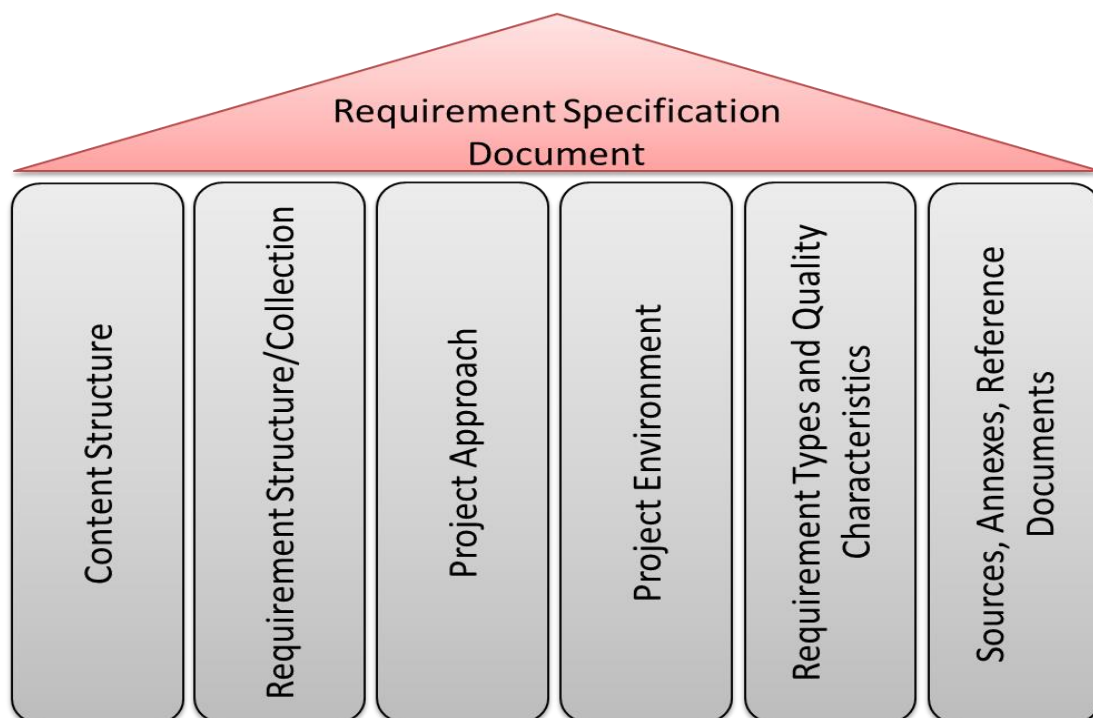


Figure 16: Pillars of the RSD

**Must-Criteria:**

Denomination	Type	Source	Weight
Description	Trigger		
FM 1	Functional	Survey	3,7
The LMS must provide a tool for intra-group-chat-communication		Direct group internal communication	
FM 2	Functional	Survey	3,2
The LMS must entail an information-board-tool for school management and administrative purposes		School administration	

Figure 17: Requirement Shell – Example

43	UI Personalisation possible	1,9	3	5,7	2	3,8	4	7,5	3	5,7	4	7,5
44	Summary Module Perspective		3,3	175,8	2,7	146,3	2,8	151,3	3,3	183,6	3,3	179,8
45	LMS adequate for User knowledge/experience level	3,1	3	9,4	3	9,4	3	9,4	3	9,4	4	12,6
46	LMS promotes motivation for ist use	3,2	3	9,5	2	6,3	2	6,3	4	12,7	4	12,7
47	Good Intuitivity	3,6	3	10,8	3	10,8	3	10,8	4	14,4	4	14,4
48	High System robustness	3,7	2	7,3	2	7,3	2	7,3	4	14,6	4	14,6
49	Accessability through school website supported	3,0	4	12,0	4	12,0	4	12,0	4	12,0	4	12,0
50	Desired profile and access managemnet supported	2,9	3	8,8	3	8,8	3	8,8	4	11,8	3	8,8
51	Mobile (Smartphone) Accessibility supported	2,8	2	5,7	1	2,8	1	2,8	3	8,5	3	8,5
52	Summary Feature Perspective		2,9	63,6	2,6	57,6	2,6	57,6	3,7	83,4	3,7	83,6
53	Max Score/ LMS mean value; LMS respective Scores	516,0	3,2	411,9	2,7	352,4	3,0	382,6	3,4	446,0	3,6	470,9
54	% Score	100%		79,81%		68,28%		74,15%		86,42%		91,25%

Figure 18: Scoring Model – Example

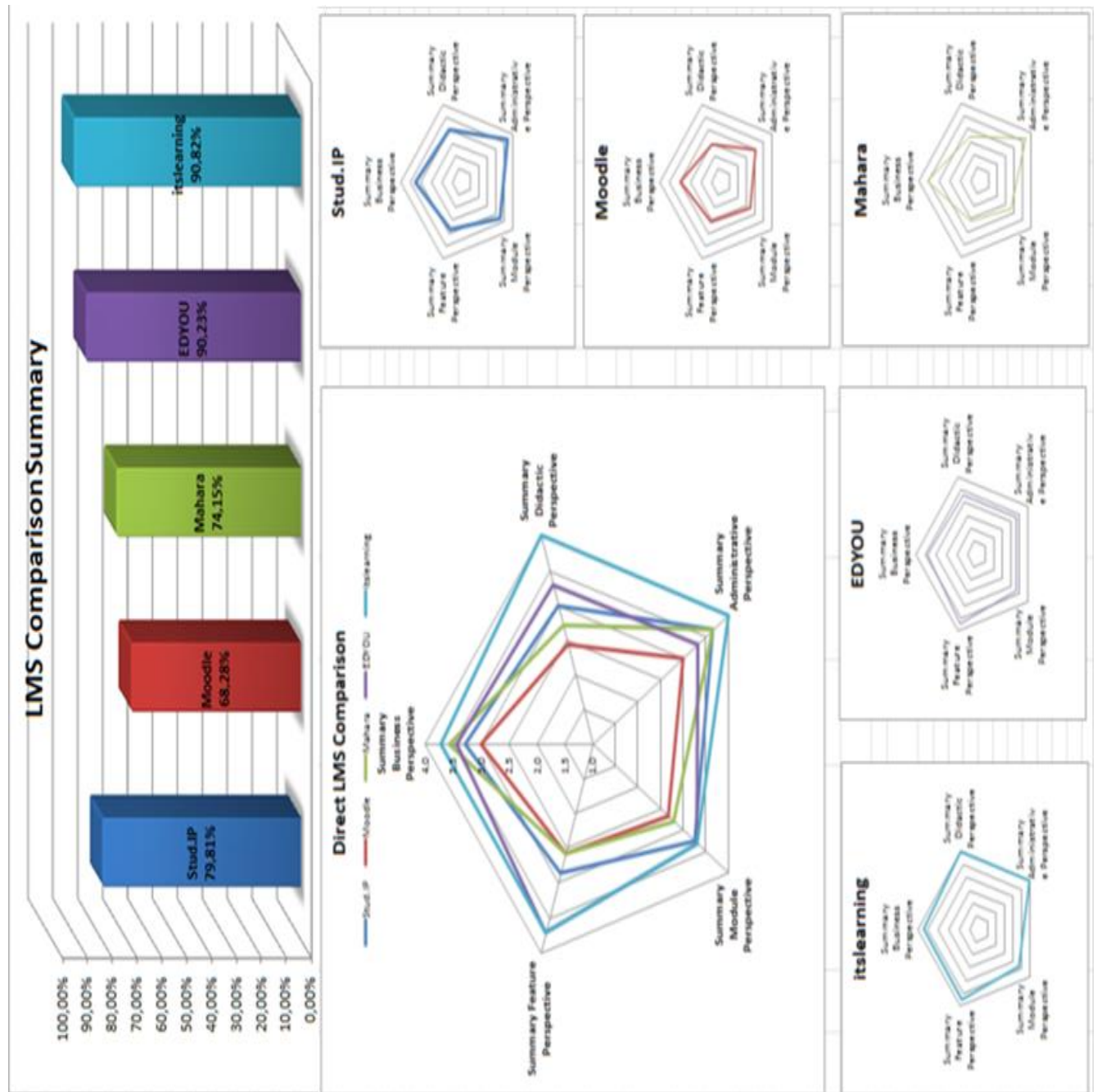


Figure 19: Soring Model – Graphical Illustrations – Example



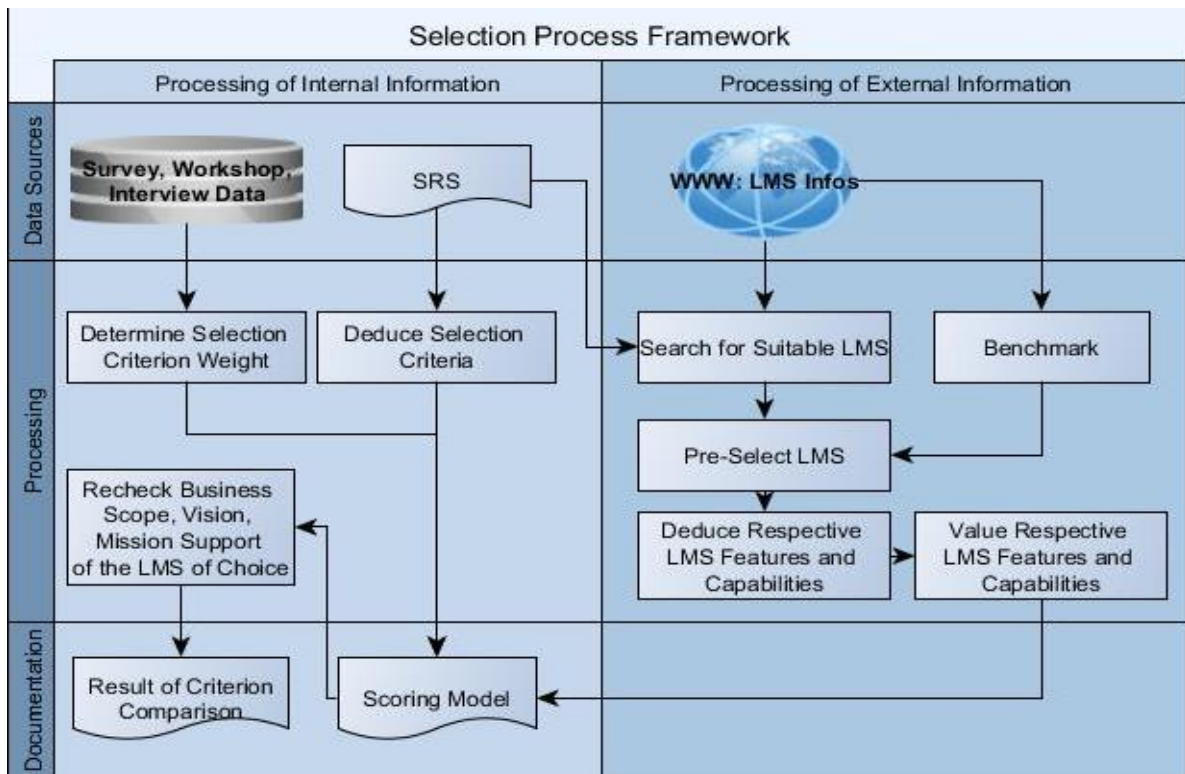


Figure 20: LMS Selection Framework – Process Model

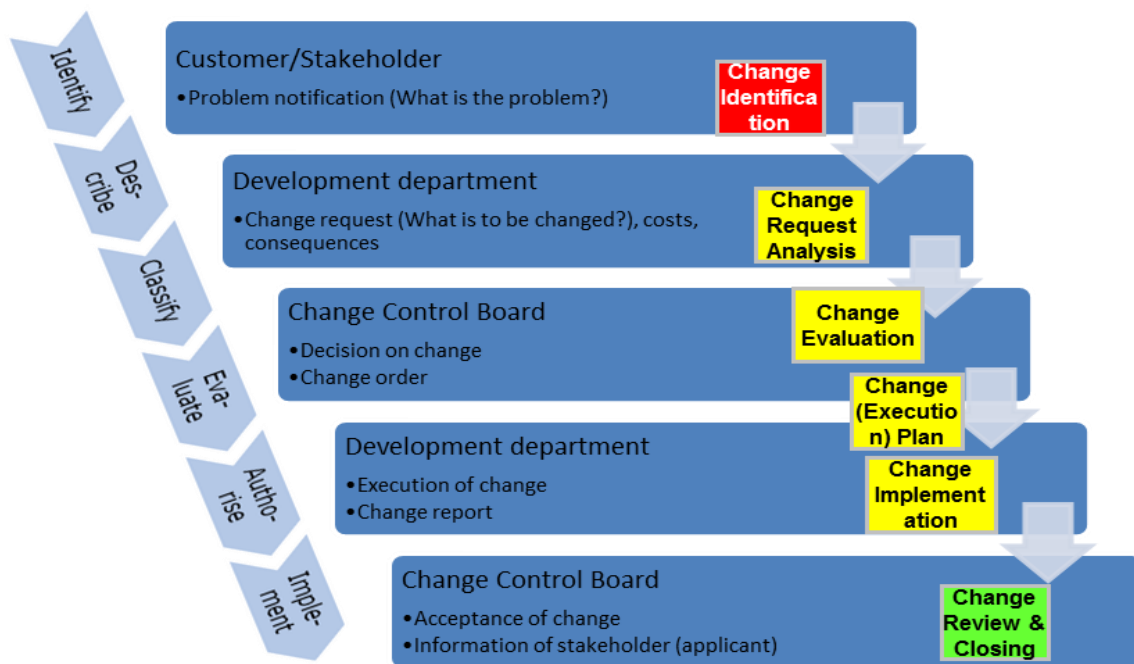


Figure 21: RCM Approach (dependent on Schelle et al., 2008)



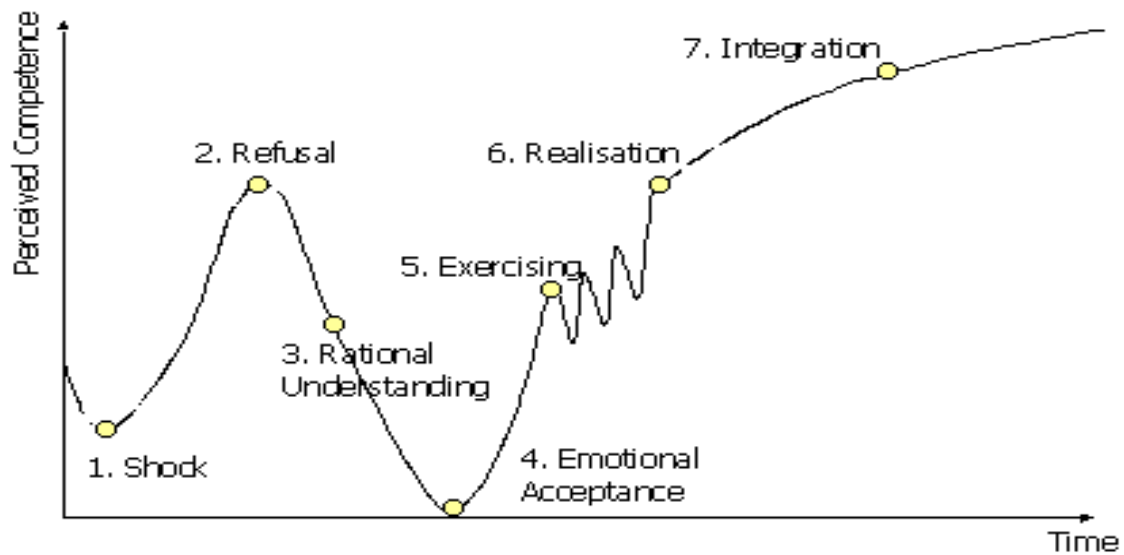


Figure 22: Phases of Change (Recklies, 2010)



Figure 23: Management specific CSF for OCM

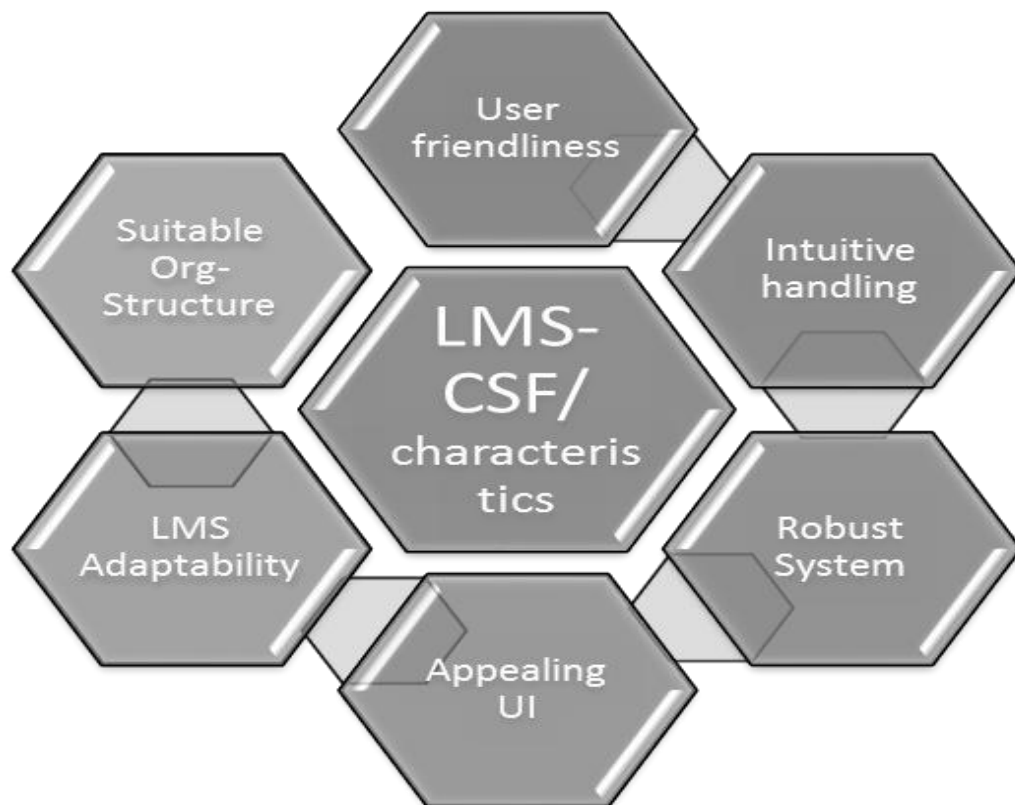


Figure 24: LMS Specific CSF for OCM

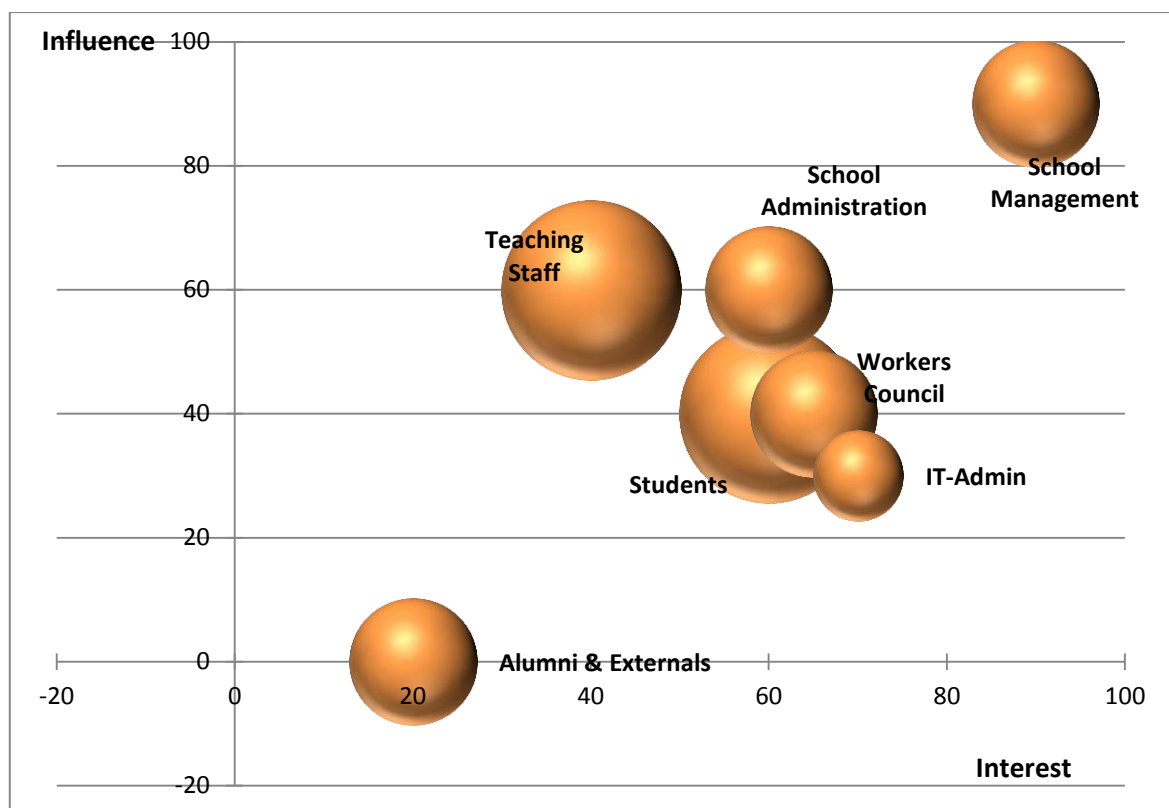


Figure 25: Stakeholder Portfolio – TA

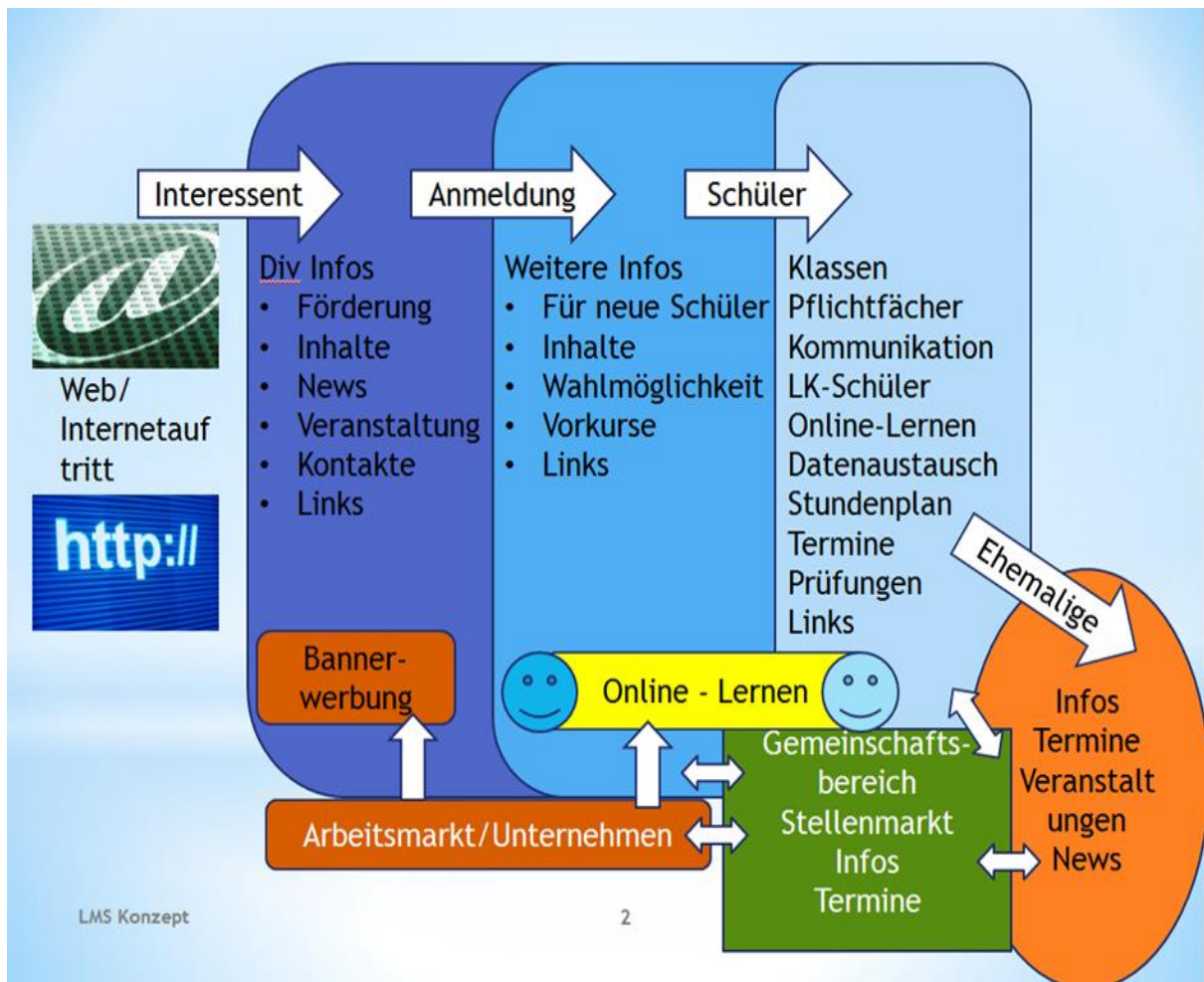


Figure 26: LMS Adaption to Business Structure (Draft in German)

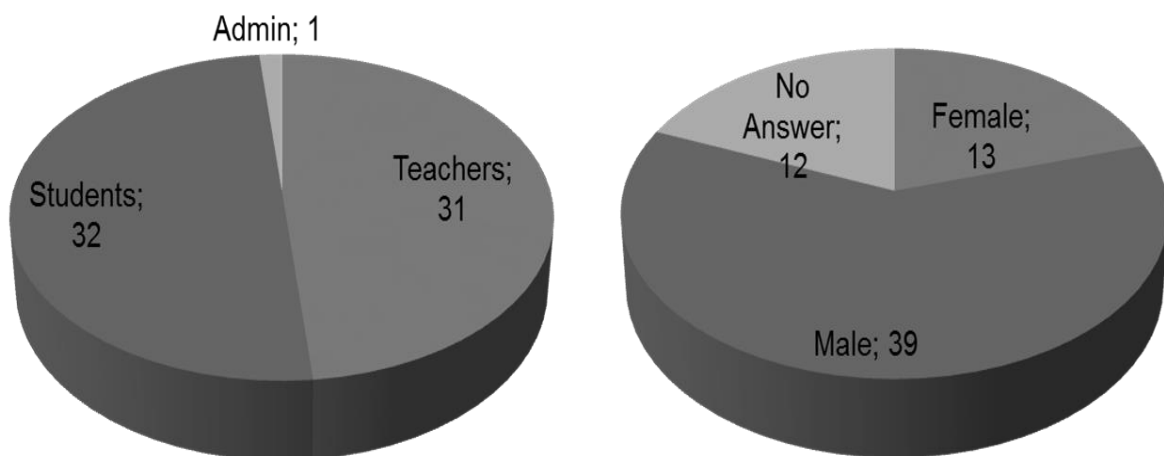


Figure 27: Survey Distribution – TA

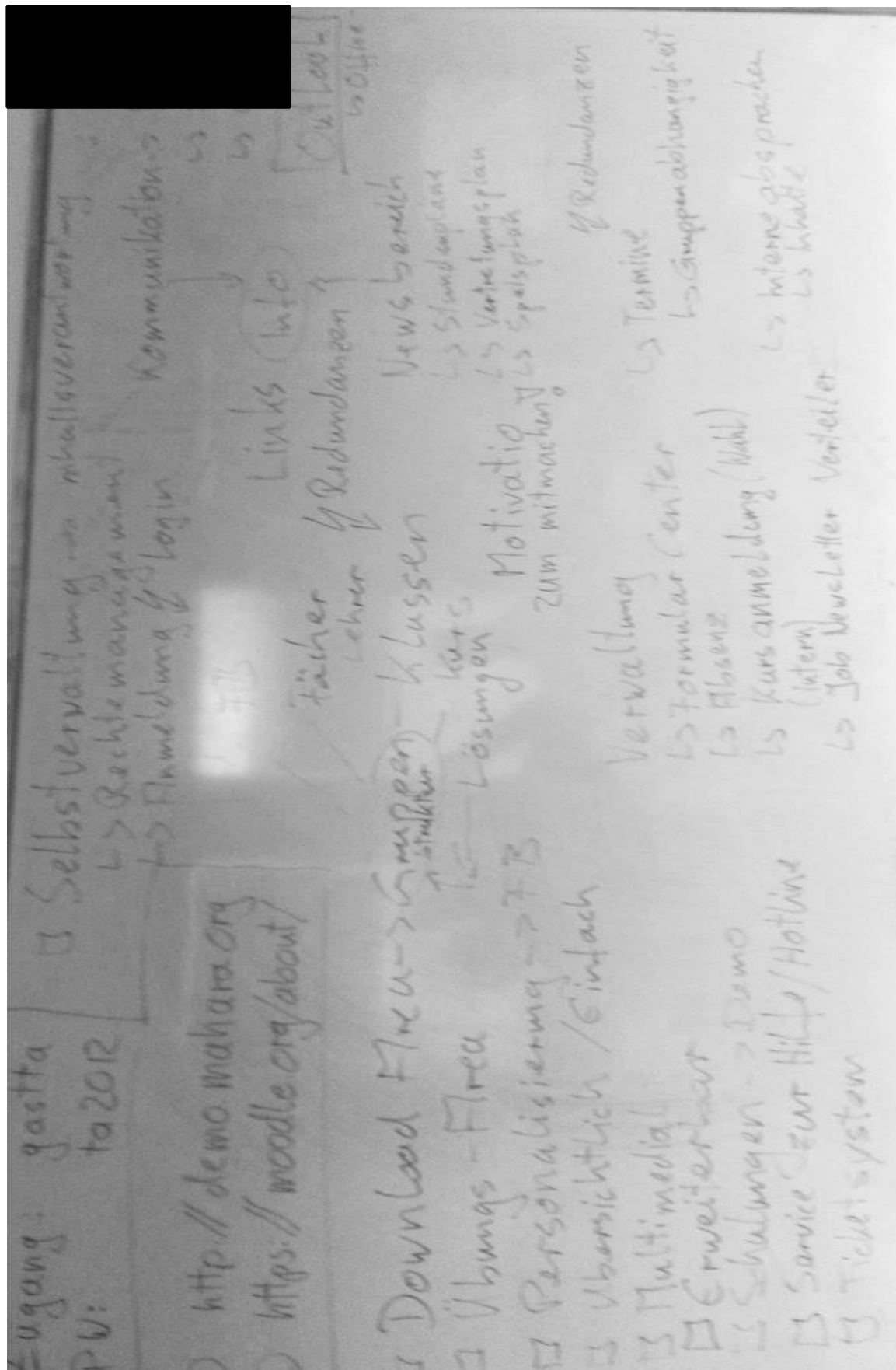


Figure 28: Brainstorming Results Orientation Workshop

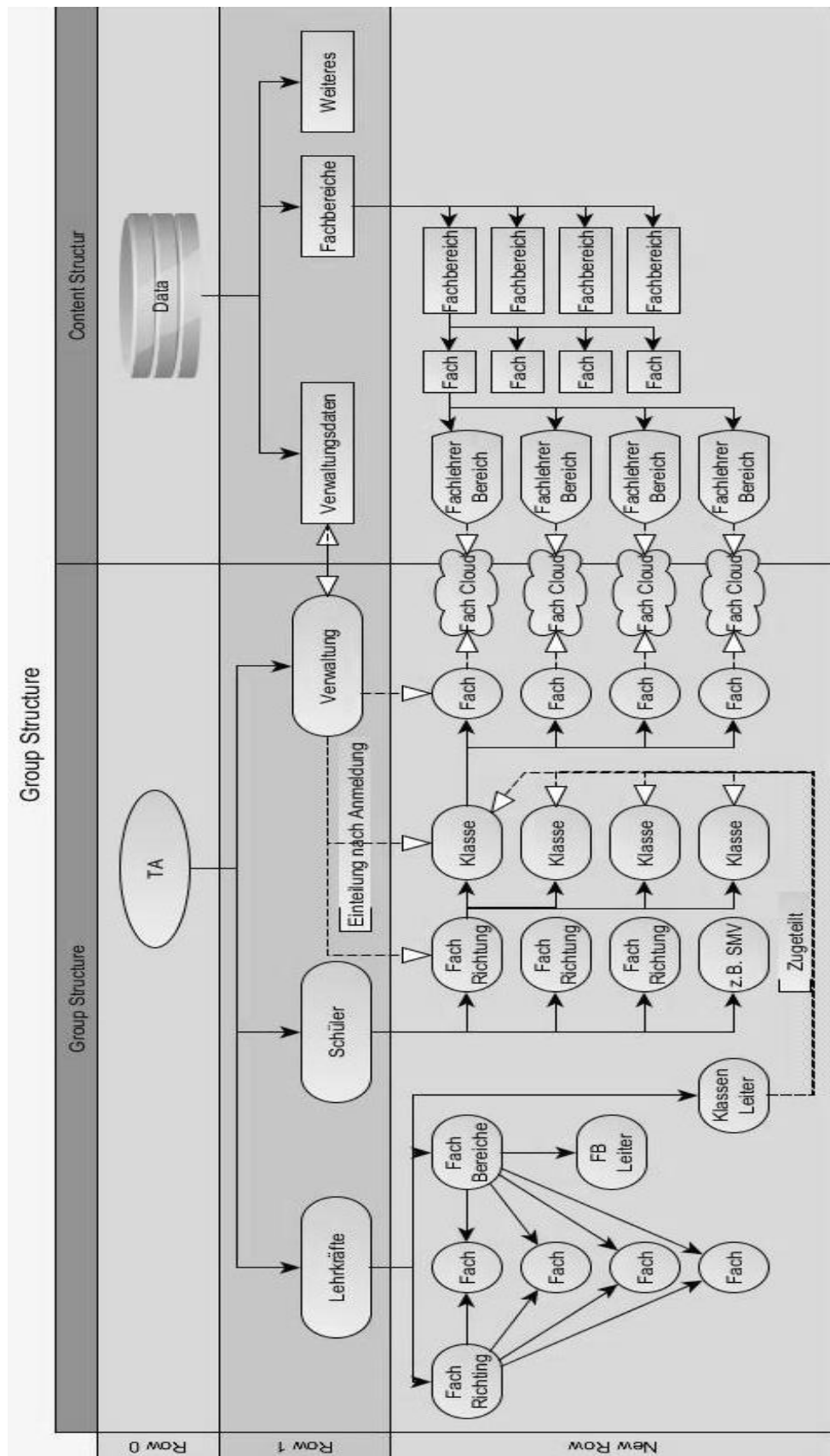


Figure 29: Concept Base for Content/Group Management – TA (in German)

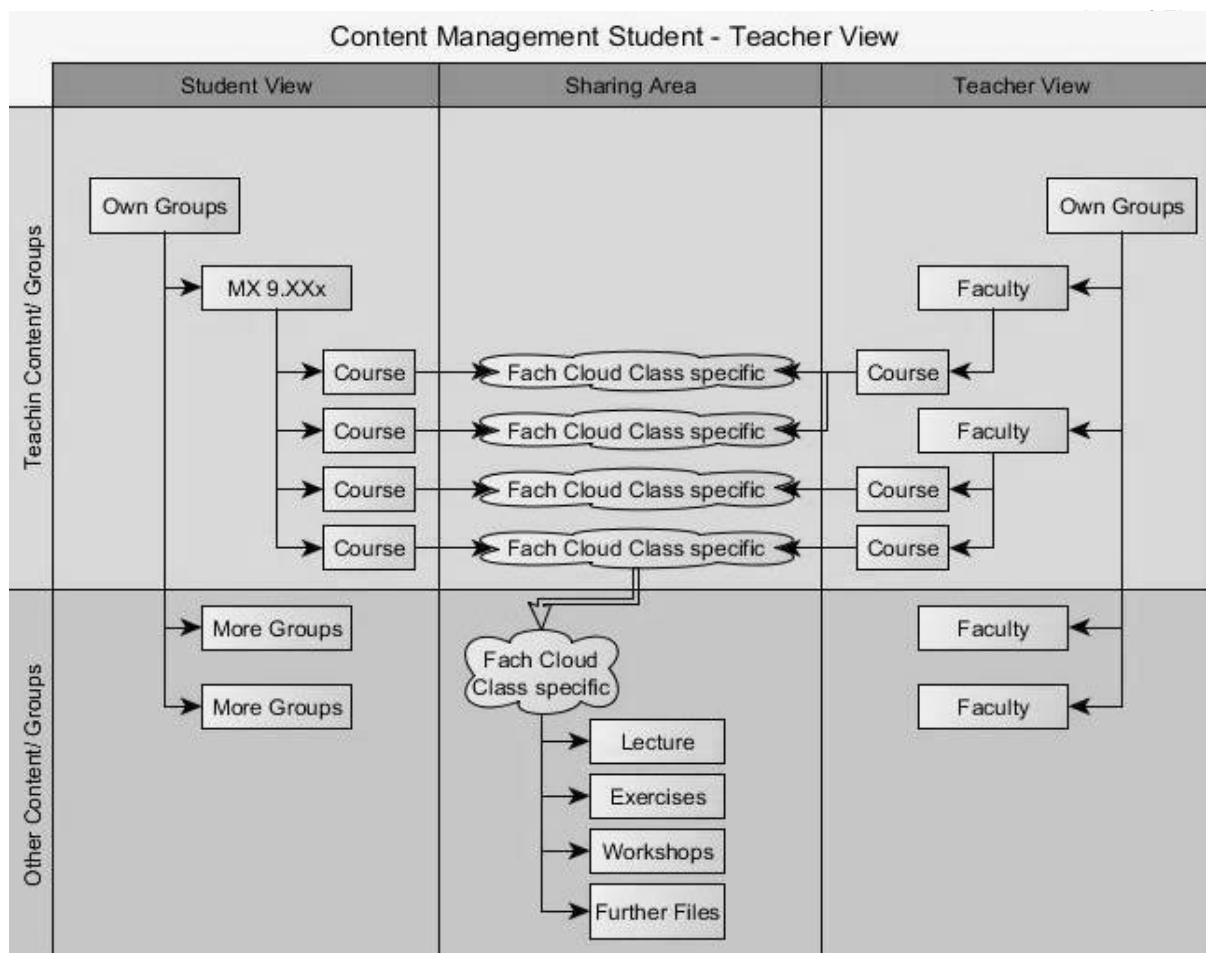


Figure 30: Content-Distribution-Management – TA

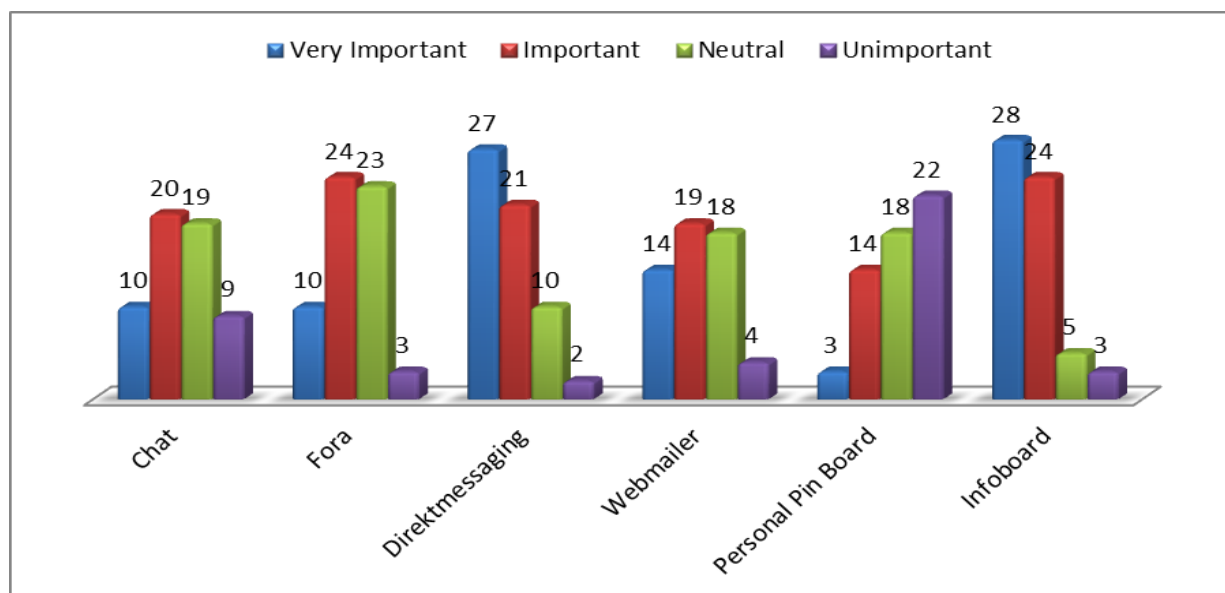


Figure 31: Weight Assessment Communication Modules – TA

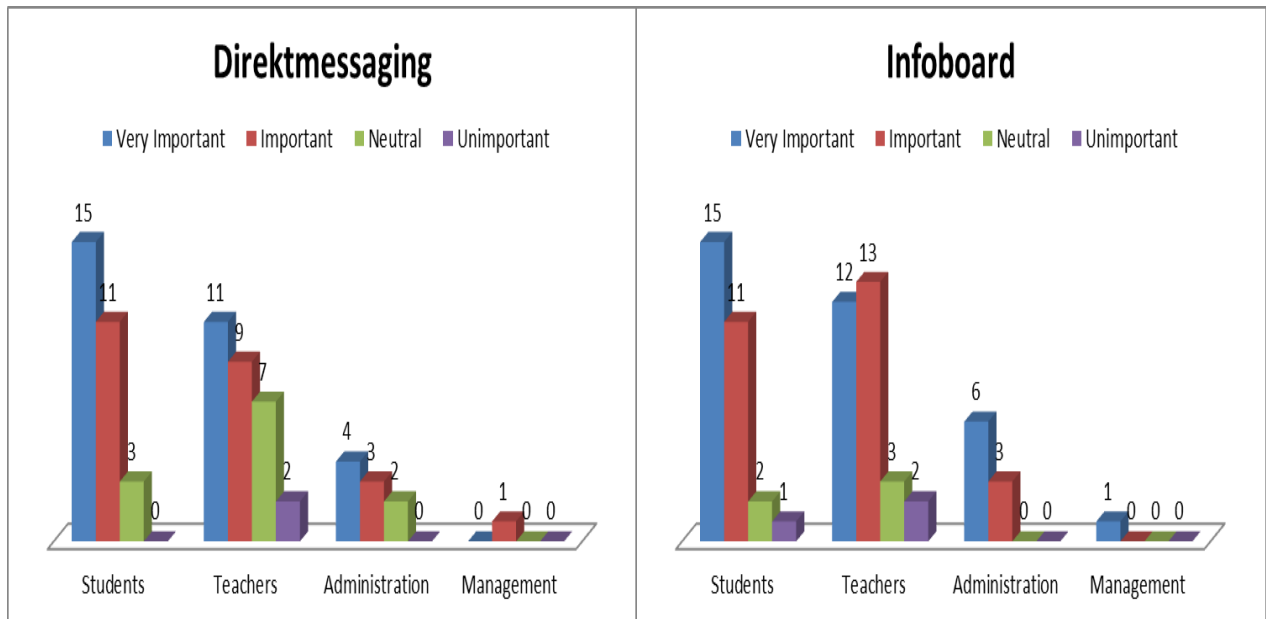


Figure 32: Stakeholder/Weight Distribution Example – TA

Stakeholder Group	Teacher		Students		Management		Administration		Alumni		Externals		Result
Stakeholder Influence (from Portfolio)	6		5		9		7		0		0		27
	Weight (Survey/WS)	Result Weight	Weight (Survey/WS)	Result Weight	Weight (Survey/WS)	Result Weight	Weight (Survey/WS)	Result Weight	Weight (Survey/WS)	Result Weight	Weight (Survey/WS)	Result Weight	
Chat Module included/ supported	2,5	15	2,8	14	3	27	3	21		0		0	2,85185185
Forum Module included/ supported	2,7	16,2	2,8	14	3	27	3	21		0		0	2,8962963
Direct Messaging Module included/ supported	3,2	19,2	3,4	17	4	36	4	28		0		0	3,71111111
Dashboard Module included/ supported	1,9	11,4	1,9	9,5	1	9	3	21		0		0	1,88518519
Personal Blog Module included/ supported	1,4	8,4	1,8	9	1	9	1	7		0		0	1,23703704
Wiki Module included/ supported	2,1	12,6	2,7	13,5	2	18	2	14		0		0	2,15185185
Infoboard Module included/ supported	3,3	19,8	3,4	17	4	36	4	28		0		0	3,73333333
Email Blast Module included/ supported	2,8	16,8	2,9	14,5	3	27	3	21		0		0	2,93703704
Email Info Module included/ supported	2,8	16,8	2,9	14,5		0	4	28		0		0	2,1962963

Figure 33: Total Criterion Weight Calculation Example – TA



Criterion	Weight	Stud.IP		Moodle		Mahara		EDYOU		itslearning	
		Grade	Result	Grade	Result	Grade	Result	Grade	Result	Grade	Result
Supports the institute's vision	3,4	3	10,1	3	10,1	3	10,1	3	10,1	4	13,4
Supports institute's mission	3,1	3	9,4	3	9,4	3	9,4	3	9,4	4	12,6
Supports Business structure	3,6	3	10,8	3	10,8	4	14,3	4	14,3	4	14,3
Supports Business Goals and Objectives	3,2	4	12,8	4	12,8	4	12,8	4	12,8	4	12,8
Technical, hardware, organizational and conceptual requirements can be met	3,0	4	11,9	3	8,9	4	11,9	3	8,9	3	8,9
Project timeframe can be kept	3,1	3	9,2	3	9,2	3	9,2	4	12,2	4	12,2
Supports the required PR Effect	2,9	3	8,7	2	5,8	4	11,7	3	8,7	3	8,7
<b>Summary Business Perspective</b>		<b>3,3</b>	<b>72,9</b>	<b>3,0</b>	<b>67,0</b>	<b>3,6</b>	<b>79,4</b>	<b>3,4</b>	<b>76,5</b>	<b>3,7</b>	<b>83,0</b>
Criteria for designated user group	3,3	3	8,5	3	6,9	3	8,5	4	12,6	4	12,6
<b>Learning Support University</b>											
Desired Online Evaluation supported (Automated, manual, open design)	2,7	3	8,2	2	5,5	2	5,5	3	8,2	4	11,0
Educational Objectives supported	3,2	3	9,6	3	9,6	3	9,6	3	9,6	4	12,8
<b>Summary Didactic Perspective</b>		<b>3,0</b>	<b>63,5</b>	<b>2,4</b>	<b>51,7</b>	<b>2,7</b>	<b>57,5</b>	<b>3,3</b>	<b>69,8</b>	<b>4,0</b>	<b>84,6</b>

Figure 34: Scoring Model Utilization Example – TA



Desired profile and access managemnet supported	2,9	3	8,8	3	8,8	3	8,8	4	11,8	3	8,8
Mobile (Smartphone) Accessibility supported	2,8	2	5,7	1	2,8	1	2,8	3	8,5	3	8,5
Summary Feature Perspective		2,9	63,6	2,6	57,6	2,6	57,6	3,7	83,4	3,7	83,6
Max Score/ LMS mean value; LMS respective Scores	516,0	3,2	411,9	2,7	352,4	3,0	382,6	3,4	446,0	3,6	470,9
% Score	100%		79,81%		68,28%		74,15%		86,42%		91,25%

Figure 35: Scoring Model Result Example – TA

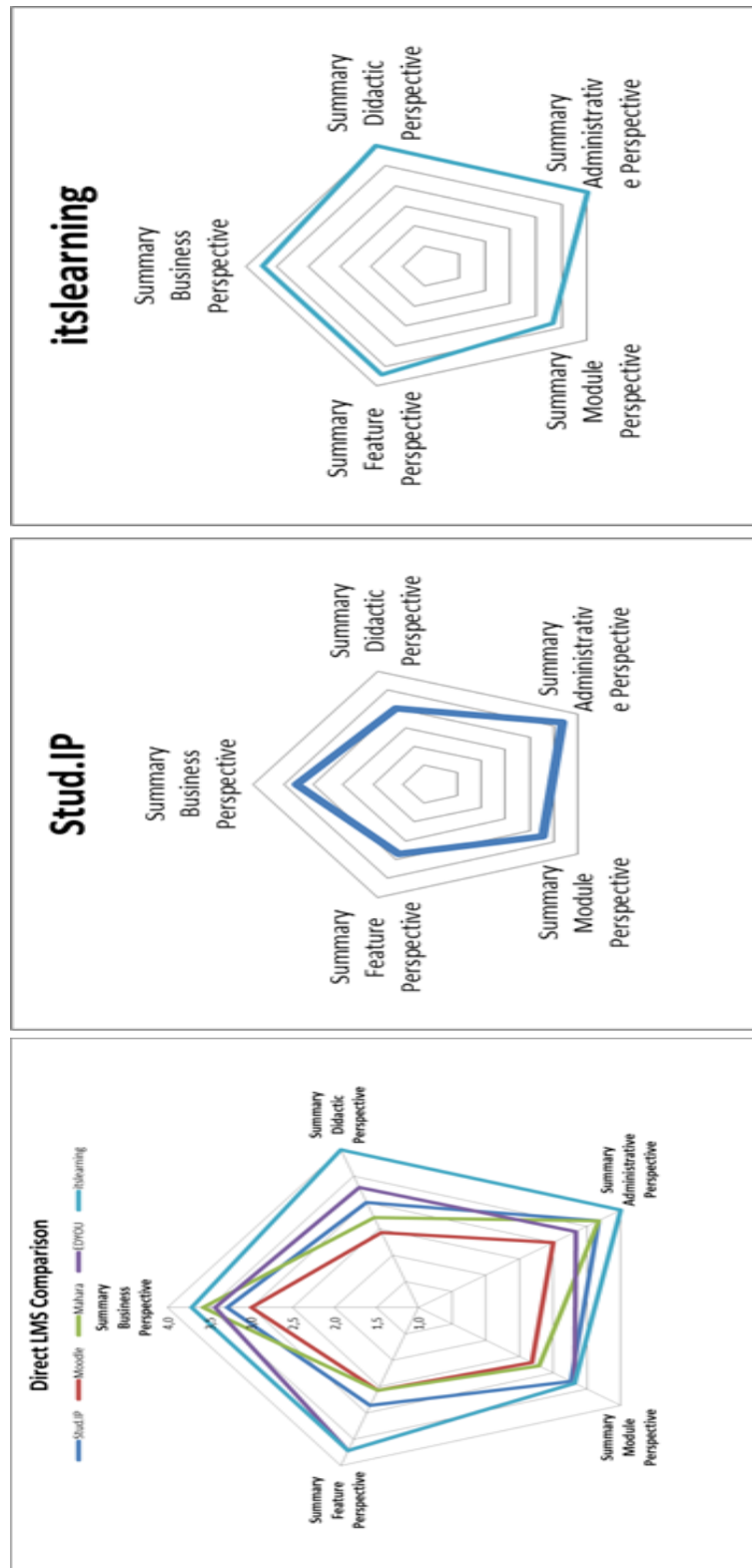


Figure 36: Web Chart Result Example – TA

	Open Source					
	Shorttime		Midtime		Longterme	
	<18 months		<36 months		>36 months	
Cost:	one time	regular	one time	regular	one time	regular
Costs of introducing and implementing an LMS at the school	5h/user + 300h for setup	---	---	---	---	---
Cost for personell (staff: utilization time)	high	middle	---	middle	---	low
Cost for hardware resources	ca 200€	1€/user to 3€/user	---	1€/user to 3€/user	---	1€/user to 3€/user
Costs for change management and continuing motivation processes	high (min 2h/user)	middle	---	low	---	low
Costs for continuous use, maintenance and service,	---	30+h/week	---	20+h/week	---	20+h/week
Cost for marketing utilization and QM	---	10h for Admin	---	10h for Admin	---	10h for Admin
Cost for adaption and further programming	---	40h for Admin	---	40h for Admin	---	40h for Admin
Cost for training and supporting	---	30h for prep 2h/user	---	30h for prep 2h/user	---	30h for prep 2h/user
Cost for additional work in restructuring and re-preparing content	high	middle	---	middle	---	low
<b>Benefit:</b>						
Benefits of additional services		high	---	middle	---	middle
Benefits of saving time and labor	negative	low	---	middle	---	middle
Benefits as marketing platform and qualifying element in the competition	---	high	---	middle	---	middle
Benefits through communication gain	---	low	---	middle	---	middle
Acceptance though modern media usage	---	high	---	high	---	middle
Expected service, Benefit of Image	high	high	---	middle	---	middle
Benefit of better results of students	---	low	---	middle	---	high
Customer satisfaction, employee satisfaction	---	high	---	middle	---	middle
Quality	---	middle	---	middle	---	middle
Saving ressources like printing material	---	low	---	middle	---	middle
Optimized data/ content structure è faster access,	---	low	---	middle	---	high
<b>Revenue</b>						

Figure 37: ECA Example OS-solution – TA

Cost Example:									
<b>1h == 8€, user == 200, user hardware == 1300, weeks == 30</b>		Exmpl: Stud.IP							
Costs of introducing and implementing an LMS at the school		10.400 €	---	---	---	---	---	---	---
Cost for hardware resources		ca. 200 €	1.300 €	---	---	1300	---	---	1300
Costs for continuous use, maintenance and service,		---	7.200 €	---	---	4.800 €	---	---	4.800 €
Cost for marketing utilization and QM		---	80 €	---	---	80	---	---	80 €
Cost for adaption and further programming		---	320 €	---	---	320	---	---	320 €
Cost for training and supporting		---	3.440 €	---	---	3.440 €	---	---	3.440 €
<b>Cost assesment (assignable numbers only)</b>		1. year	ca. 23 000 €	following year	---	ca. 10000 €	---	---	---
<b>Cost assesment (assignable numbers only, hour correction; not advisable)</b>		1. year	ca. 6500 €	following year	---	ca. 4000 €	---	---	---
Exmpl: EDYOU (EDYOU's most expensive service contract)									
Costs of introducing and implementing an LMS at the school		6.200 €	---	---	---	---	---	---	---
Cost for hardware resources		---	1.300 €	---	---	1.300 €	---	---	1.300 €
Costs for continuous use, maintenance and service,		---	1.000 €	---	---	1.000 €	---	---	1.000 €
Cost for marketing utilization and QM		---	incl.	---	incl.	---	---	incl.	---
Cost for adaption and further programming		---	incl.	---	incl.	---	---	incl.	---
Cost for training and supporting		---	3200	---	---	3200	---	---	3200
<b>Cost assesment (assignable numbers only)</b>		1. year	ca. 11700 €	following year	---	ca. 5500 €	---	---	---
<b>Cost assesment (assignable numbers only, hour correction; not advisable)</b>		1. year	ca. 3700 €	following year	---	ca. 2300 €	---	---	---
Exmpl: itslearning									
Costs of introducing and implementing an LMS at the school		6.200 €	---	---	---	---	---	---	---
Cost for hardware resources		---	6.500 €	---	---	6.500 €	---	---	6.500 €
Costs for continuous use, maintenance and service,		---	1.000 €	---	---	1.000 €	---	---	1.000 €
Cost for marketing utilization and QM		---	incl.	---	incl.	---	---	incl.	---
Cost for adaption and further programming		---	incl.	---	incl.	---	---	incl.	---
Cost for training and supporting		---	3200	---	---	3200	---	---	3200
<b>Cost assesment (assignable numbers only)</b>		1. year	ca. 16900 €	following year	---	ca. 10700 €	---	---	---
<b>Cost assesment (assignable numbers only, hour correction; not advisable)</b>		1. year	ca. 8900 €	following year	---	ca. 7500 €	---	---	---

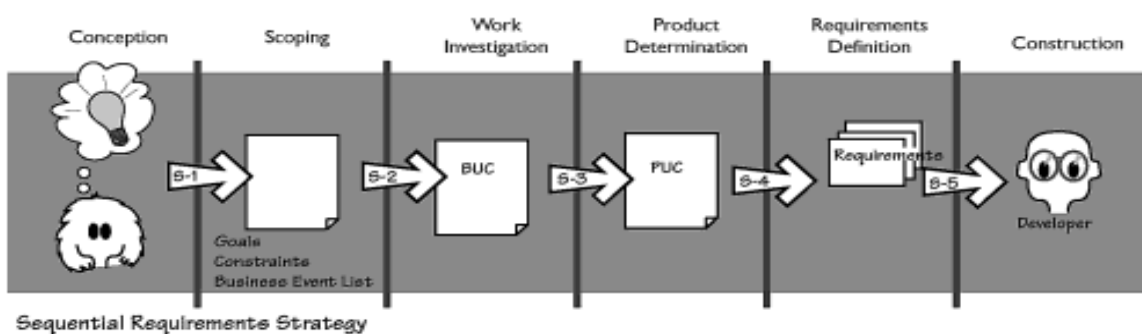
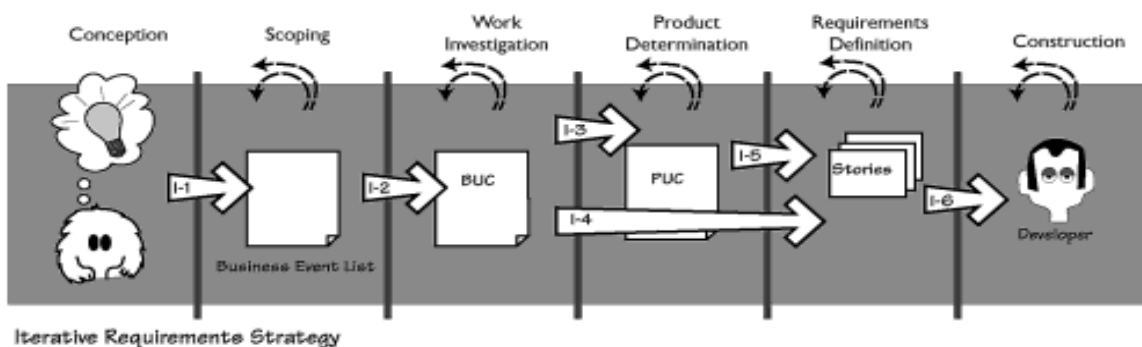
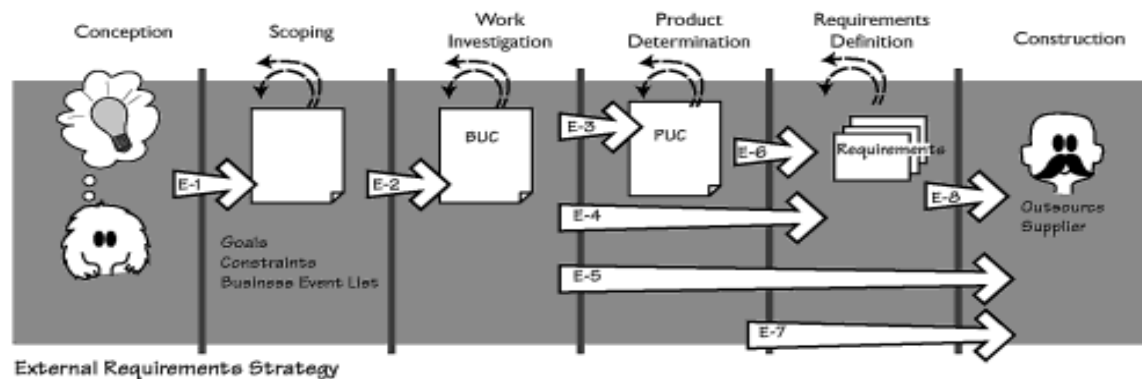
Figure 38: Cost-Structure Example Calculations – TA

# Appendices

## Appendix E Different RE Strategies

By Cockburn (2001)

### Requirements Strategy Maps



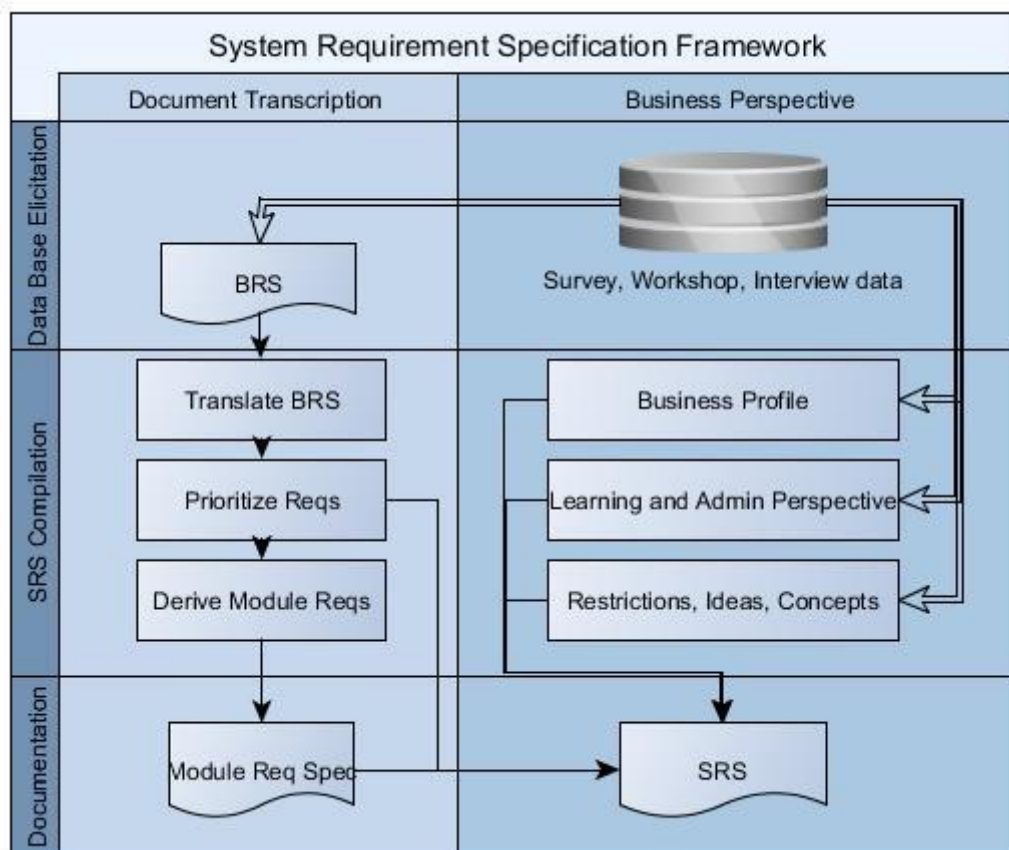
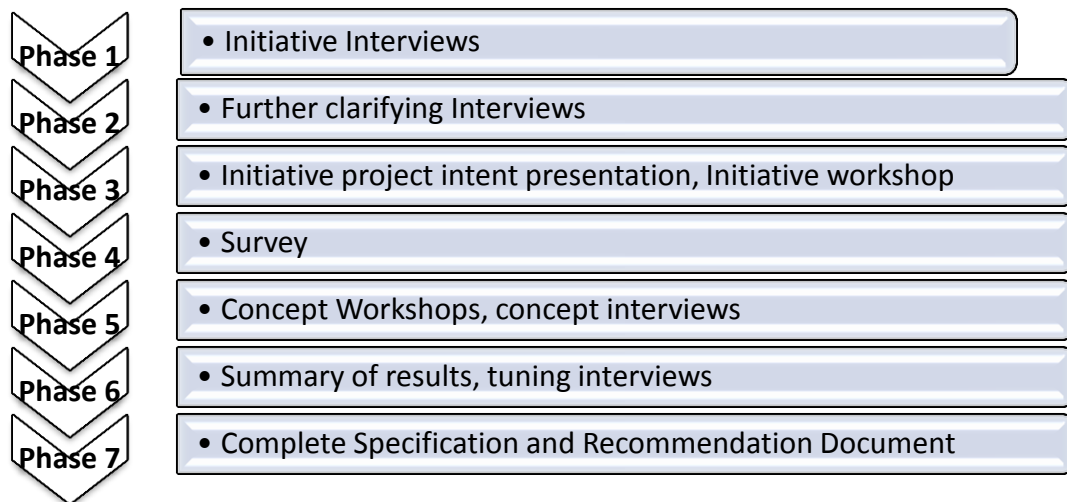


## Appendix F Roots of eLearning

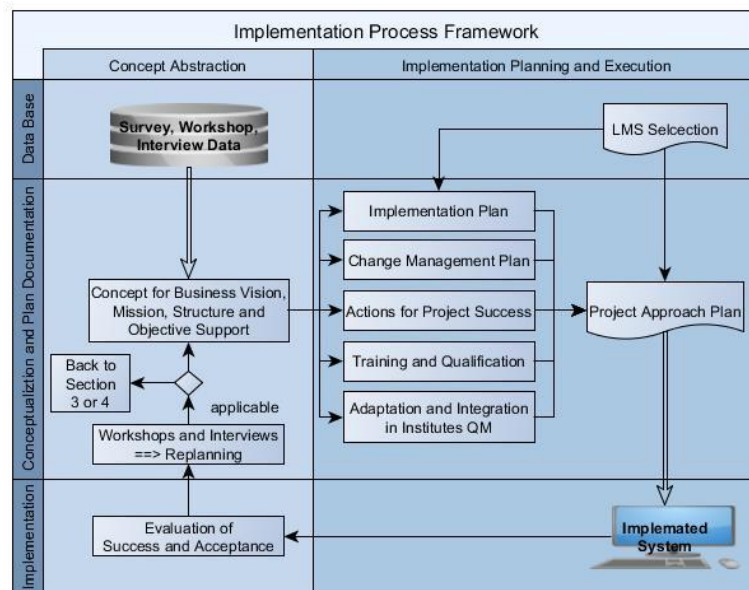
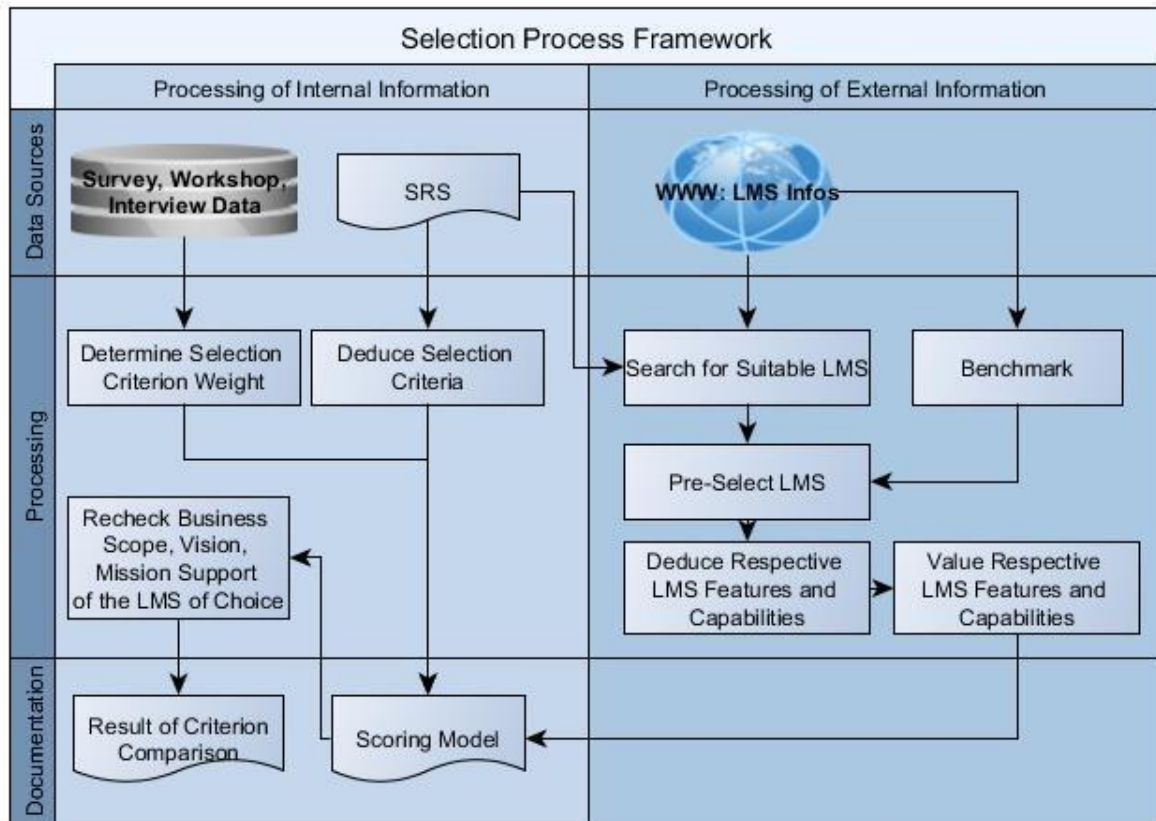
By Folden (2011)



## Appendix J Reference Architecture

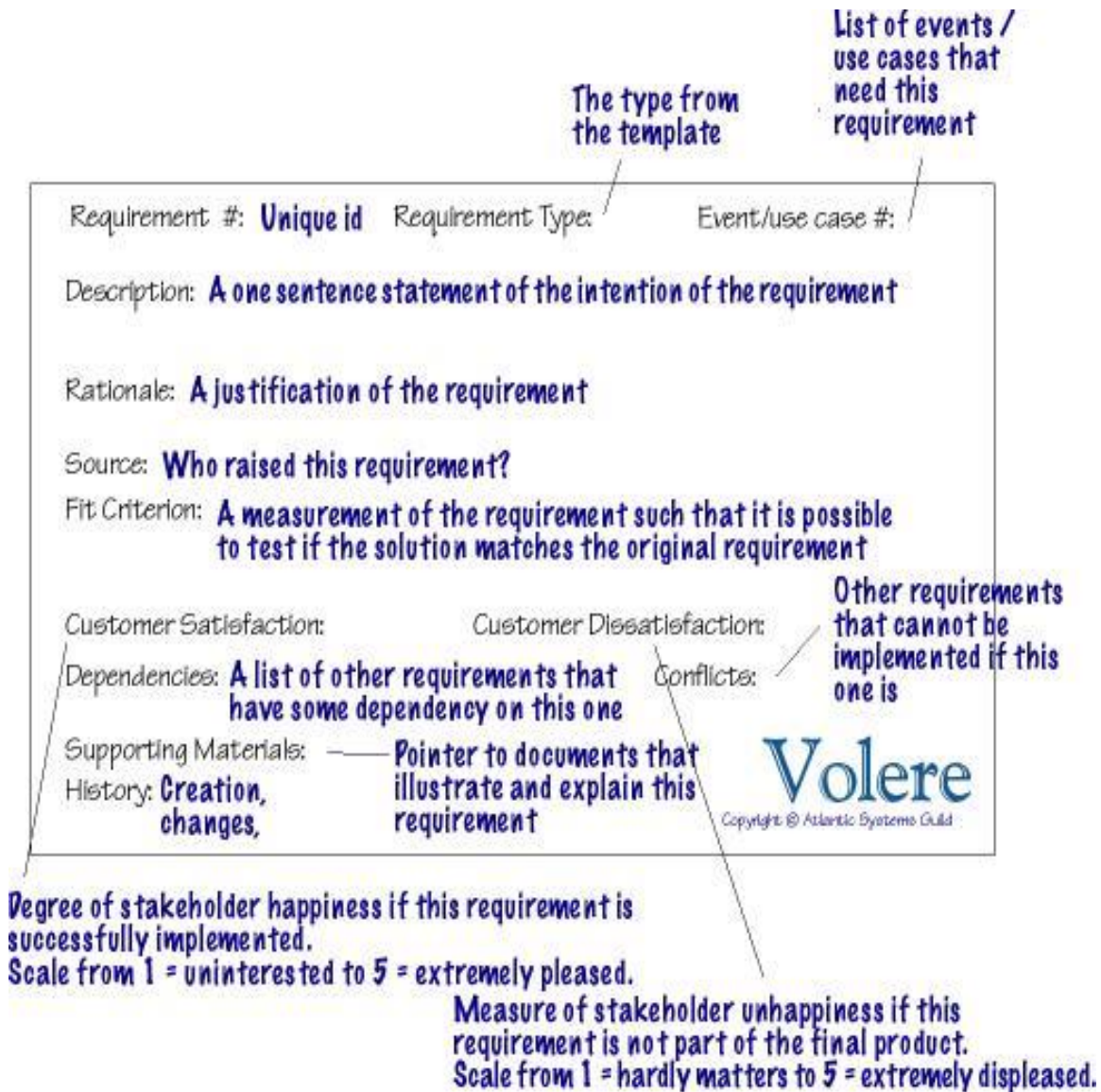






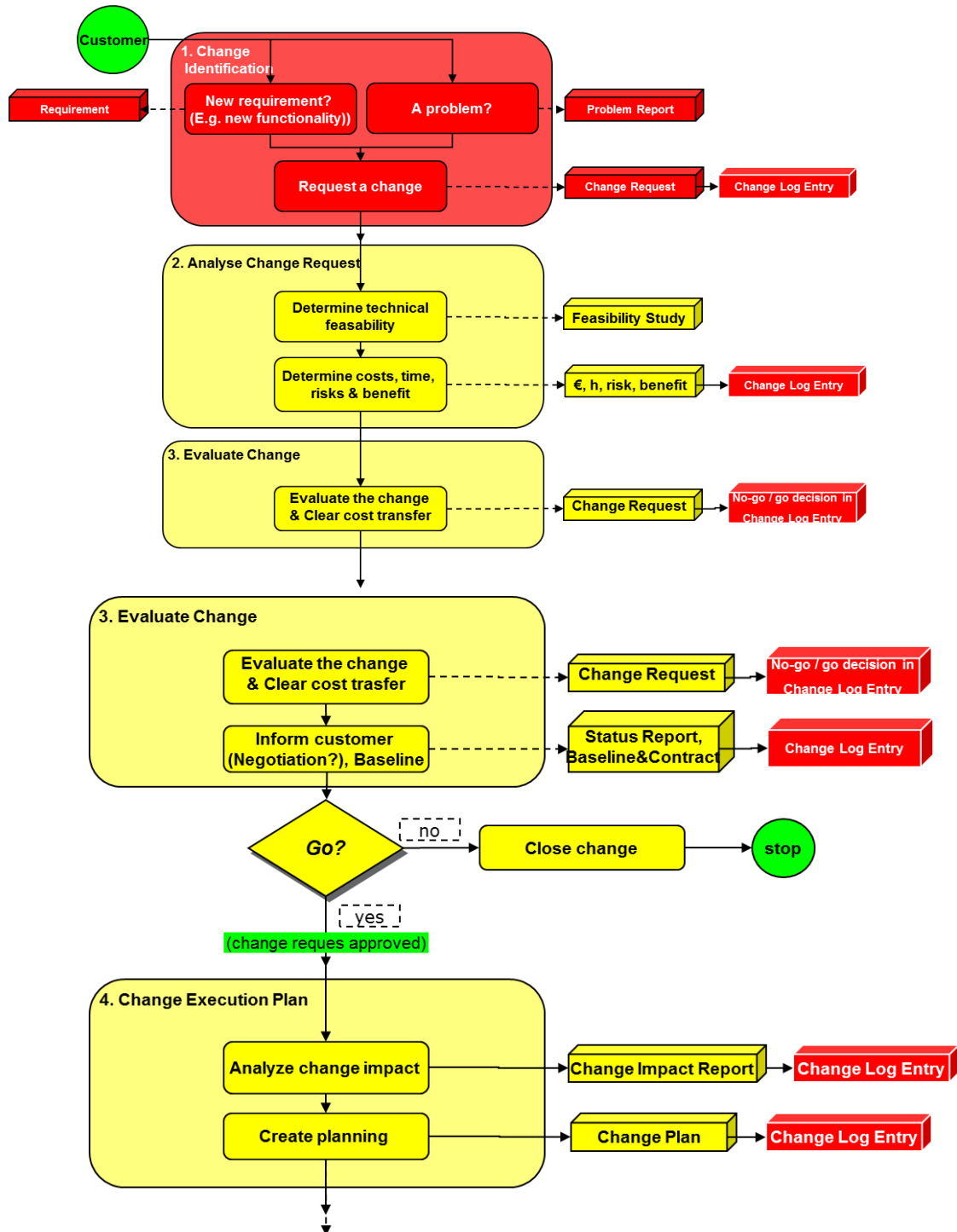
## Appendix R Requirement Shell – Volere

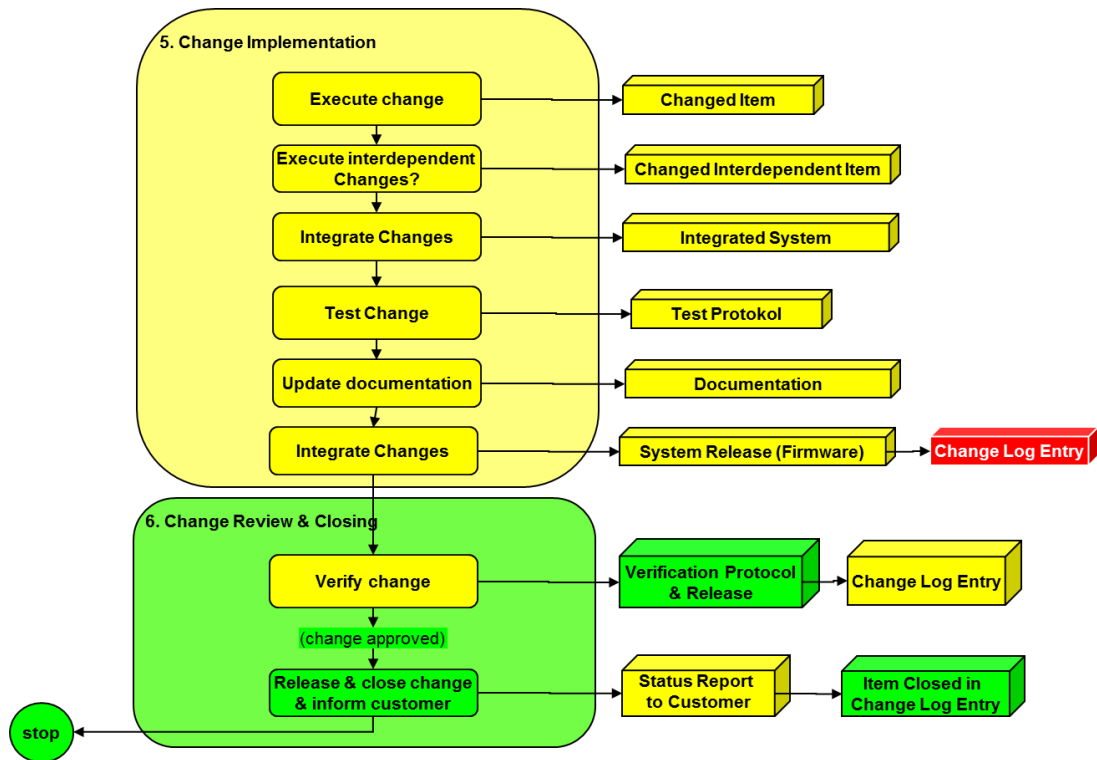
By Robertson & Robertson (2003):



## Appendix S Requirement Change Management Process

In concordance with Schelle et al. (2008)





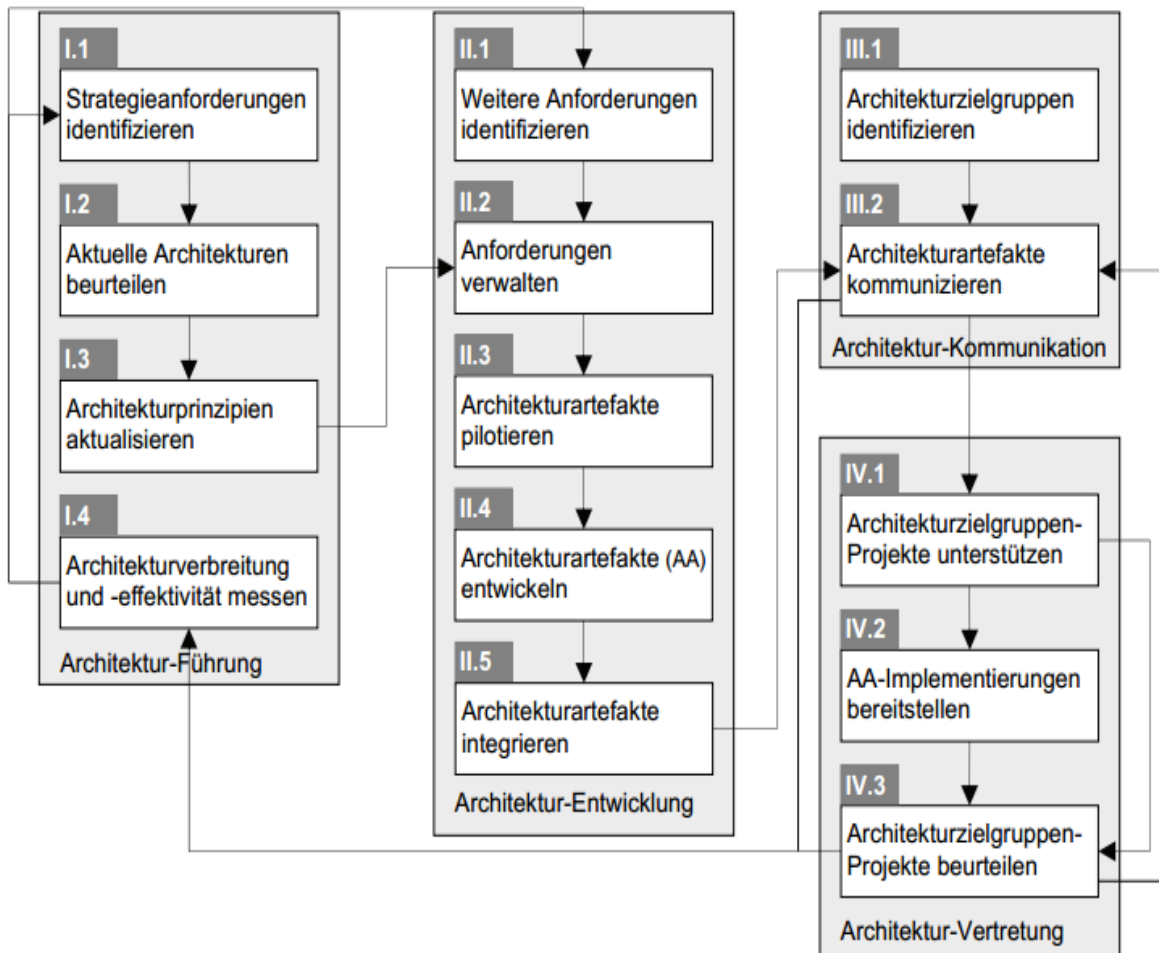
## Appendix T Change Management - CSFs

By Government of Queensland (2008)



## Appendix U Architecture Management Approach

By Hafner & Winter (2005):



Requirement Engineering for Knowledge-Intensive  
Processes

Reference Architecture for the Selection of a Learning  
Management System

Wundenberg, S.-M.

2015, XV, 125 p. 38 illus., Softcover

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