Designing for Sustainability when Architecture Standards are involved: an industrial Case Study

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Appendix A. Sustainability Impacts of Data Platform A

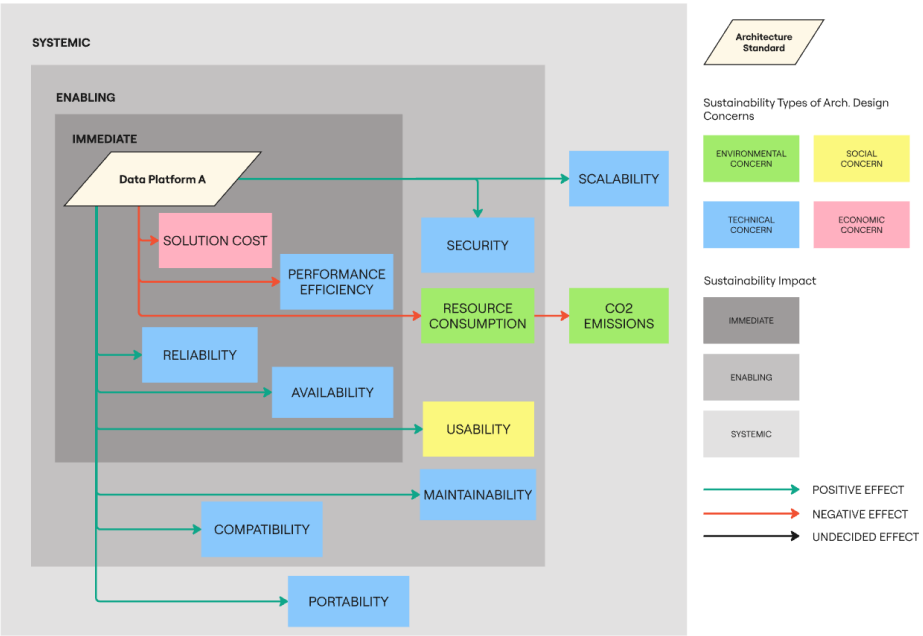

Fig. 1. Decision map for DP-A

Appendix B. Sustainability Impacts of Data Platform B

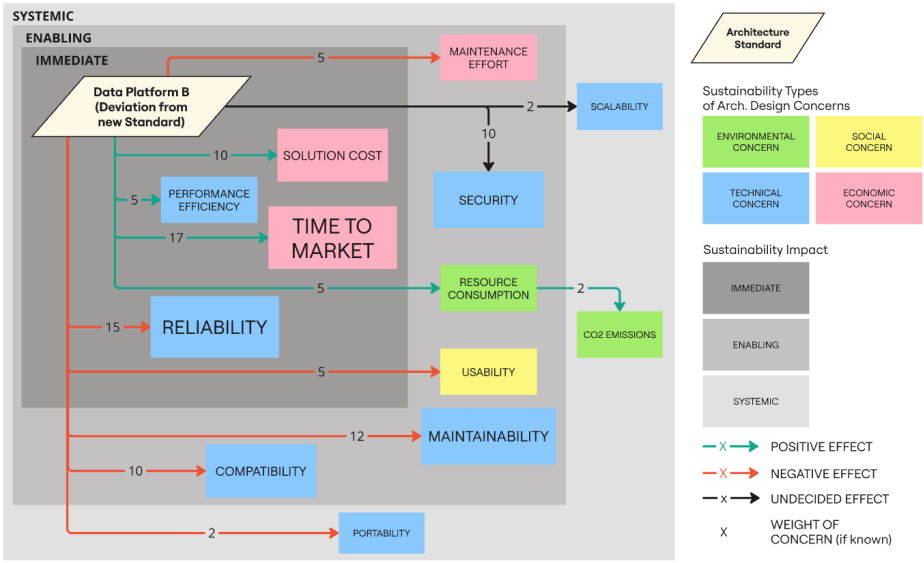

Fig. 2. Decision map for DP-B

Appendix C. Sustainability Concerns

Concerns which are not adopted from the ISO/IEC 25010:2012 standard have been presented with a gray background color.

Table 1: Identified sustainability concerns.

Sustainability Concern	**Sub-concern**	**Definition**	**Weight**	**Sustainability Dimension**
Time to Market	-	The duration between the conception of a product or service and its availability to intended users/customers	17	Economic
Reliability	Availability	The degree to which a system, product or component is operational and accessible when required for use	15	Technical
	Recoverability	The degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system		
Maintainability	Modularity	The degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components	12	Technical
	Modifiability	The degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality		

Compatibility	Interoperability	The degree to which two or more systems, products or components can exchange information and use the information that has been exchanged	10	Technical
Security	Integrity	The degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data	10	Technical
Solution Cost	-	The expenditure associated with implementing and running a software solution	10	Economic
Performance Efficiency	Time Behaviour	The degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements	5	Technical
Resource Consumption	-	The amount of different resources used by a system over a specified period	5	Technical
Usability	Learnability	The degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use	5	Social
	Operability	The degree to which a product or system has attributes that make it easy to operate and control		

Maintenance Effort	-	The effort or cost required for the correction or modification of a software product after delivery, to correct faults, to improve performance or other attributes, or to adapt the product to a changed environment	5	Economic
Portability	Adaptability	The degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments	2	Technical
Scalability	-	The capacity of a software solution to grow or shrink in response to changing demands	2	Technical
CO_2 Emissions	-	CO_2 from burning oil, coal, natural gas and waste materials for energy use	2	Environmental
			Total = 100	

Appendix D. Key Performance Indicators

Color coding indicates which fields were existing and reused (gray), or missing and added (white).

Sustainability Concern: Time to Market					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Gain competitive market advantage	Launch product within target time	Time Deviation (%)		Time Deviation = (—Lead time - Target time— / Target time) × 100	Lead time, Target time
		Target	**Action**		
		A: $\leq$ 5%	Streamline development and production processes		
		B: 6 to 10%			
		C: 11 to 20%			
		D: 21 to 50%			
		E: $\geq$ 50%			

Table 2. KPI for Time to Market

Sustainability Concern: Reliability					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Offer reliable service to users	Pass quality check	Reliability		Severity level of the worst open bug	Severity level of bugs, Number of bugs
		Target	**Action**		
		A: 0 Bugs	Resolve open bugs, prioritizing the most severe ones		
		B: at least 1 Minor Bug			
		C: at least 1 Major Bug			
		D: at least 1 Critical Bug			
		E: at least 1 Blocker Bug			

Table 3. KPI for Reliability (gray fields taken from SonarQube)

Sustainability Concern: Maintainability					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Reduce technical debt	Pass quality check	Maintainability		Maintainability = Lines of Code (LOC) / Estimated code smell fix time	Lines of Code, Estimated time to fix code smells
		Target	**Action**		
		A: $\leq$ 5%	Static code analysis, code review, and refactoring		
		B: 6 to 10%			
		C: 11 to 20%			
		D: 21 to 50%			
		E: $\geq$ 50%			

Table 4. KPI for Maintainability (gray fields taken from SonarQube & IT Strategy)

Sustainability Concern: Security					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Comply with security regulations	Pass quality check	Security		Severity level of the worst open vulnerability	Severity level of vulnerabilities, Number of vulnerabilities
		Target	**Action**		
		A: 0 Vulnerabilities B: at least 1 Minor Vulnerability C: at least 1 Major Vulnerability D: at least 1 Critical Vulnerability E: at least 1 Blocker Vulnerability	Security logging, monitoring, and vulnerability management		

Table 5. KPI for Security (gray fields taken from SonarQube & IT Strategy)

Sustainability Concern: Compatibility					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Build a simplified, lean IT landscape	Integrate seamlessly with external and standardized platforms	Compatibility		Number of compatibility issues	Number of compatibility issues per release cycle
		Target	**Action**		
		A: 0 compatibility issues per release cycle B: 1-2 compatibility issues per release cycle C: 3 or more compatibility issues encountered per release cycle	Perform integration testing and use standard protocols & platforms		

Table 6. KPI for Compatibility (gray fields taken from IT Strategy)

Sustainability Concern: Solution Cost					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Mitigate financial risk	Keep cost within spend target	Spend Deviation (%)		Spend Deviation = (—Actual spend - Spend target— / Spend target) × 100	Actual spend, Spend target
		Target	**Action**		
		A: $< 15\%$ deviation per month B: $\geq 15\%$ deviation per month	Monitor and control deployments		

Table 7. KPI for Solution Cost (gray fields taken from Cost Dashboard & related documentation)

Sustainability Concern: Performance Efficiency					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Increase IT efficiency	Meet the established performance criteria	Average Response Time (ms)		Average response time	Response times
		Target	**Action**		
		A: <120ms avg. response time B: ≥120ms avg. response time	Root cause analysis		

Table 8. KPI for Performance Efficiency (gray fields taken from Azure Dashboard & IT Strategy)

Sustainability Concern: Resource Consumption					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Optimize resource usage	Keep consumption below the set baseline	Application Consumption		Out-of-Pocket (OOP) costs	OOP costs per vendor
		Target	**Action**		
		A: consumption ≤ monthly budget B: consumption > monthly budget	Root cause analysis		

Table 9. KPI for Resource Consumption (gray fields taken from Azure Dashboard & IT Strategy)

Sustainability Concern: Usability					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Improve employee experience	Increase adoption by developers	Developer Satisfaction		Ease of use	Level of ease of use
		Target	**Action**		
		A: Easy B: Average C: Complicated	Improve tooling and support		

Table 10. KPI for Usability

Sustainability Concern: Maintenance Effort					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Minimize financial risk	Close open incidents in time	Incident		Mean Time to Restore (MTTR)	Time to restore services, Baseline time
		Target	**Action**		
		A: MTTR ≤ Baseline time B: MTTR > Baseline time	Root cause analysis		

Table 11. KPI for Maintenance Effort (gray fields taken from Operations Dashboard)

Sustainability Concern: Portability					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Increase IT efficiency	Keep failed changes within threshold	Deployment Fail Rate (%)		Deployment Fail Rate = (Number of failed deployments / Total number of deployments) × 100	Total number of deployments, Number of failed deployments
		Target	**Action**		
		A: Deployment Fail Rate ≤ 5%	Analyze independent platform issues		
		B: Deployment Fail Rate > 5%			

Table 12. KPI for Portability (gray fields taken from Operations Dashboard & IT Strategy)

Sustainability Concern: Scalability					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Generate business value	Optimize cloud capacity	Cloud Savings		Potential Cost Savings	Potential cost savings per month
		Target	**Action**		
		A: Savings per month > 250€	Implement recommendations		
		B: Savings per month ≤ 250€			

Table 13. KPI for Scalability (gray fields taken from Operations Dashboard & IT Strategy)

Sustainability Concern: CO_2 Emissions					
Goal	**CSF**	**KPI**		**Metric**	**Measure**
Reduce CO_2 by 50% in IT operations	Resolve spikes in emissions	CO_2 Emissions ($MtCO_2e$)		Electricity consumption (kWh)	Baseline electricity consumption, Monthly moving average of electricity consumption
		Target	**Action**		
		A: Monthly moving average ≤ Baseline consumption	Root cause analysis		
		B: Monthly moving average > Baseline consumption			

Table 14. KPI for CO_2 Emissions (gray fields taken from Sustainable IT Dashboard & IT Strategy)