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Cross-Impact Balance Analysis - Guideline no. 4

Prior knowledge: Guideline no. 1 Last update: May 29, 2014

Key figures used in the analysis of CIB scenarios[1]

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CIB scenarios are generally assessed according to the following key figures

- consistency score (and/or inconsistency score respectively)
- total impact score

They reveal information on the plausibility, robustness and logical homogeneity of the scenarios and are described as follows. The simple working example used in Guideline no. 1 has once again been used for ease of illustration. It addresses the interdependence of opinions within a social group.

Tom, Lisa, Paul, Katja and Max are individuals who mutually influence each other's opinions concerning a specific issue. In this instance the CIB scenarios reveal what groups of opinions might potentially form. More details can be found in the CIB Guideline no. 1[3]. In the table shown the scenario z = [-,-,+,-,-] (Tom and Lisa disagree, Paul agrees, Katja and Max disagrees) is tested for its consistency. The arrows above the impact balance denote the scenario states, the arrows below the impact balance indicate the states with maximum impact score. In accordance with the CIB principle of consistency descriptors are defined as being inconsistent if the two arrows do not point to the same states.

	1.Tom + 0 -	2.Lisa + 0 -	3.Paul + 0 -	4.Katja + 0 -	5.Max + 0 -
1.Tom:					
+		0 0 0	0 0 0	0 0 0	1 0 -1
0		0 0 0	0 0 0	0 0 0	0 0 0
-		0 0 0	0 0 0	0 0 0	-1 0 +1
2.Lisa:					
+	0 0 0		0 0 0	0 0 0	2 0 -2
0	0 0 0		0 0 0	0 0 0	0 0 0
-	0 0 0		0 0 0	0 0 0	-2 0 2
3.Paul:					
+	0 0 0	0 0 0		2 0 -2	0 0 0
0	0 0 0	0 0 0		0 0 0	0 0 0
-	0 0 0	0 0 0		-2 0 2	0 0 0
4.Katja:					
+	3 0 -3	2 0 -2	2 0 -2		0 0 0
0	0 0 0	0 0 0	0 0 0		0 0 0
-	-3 0 3	0 0 0	-2 0 2		0 0 0
5.Max:					
+	2 0 -2	1 0 -1	-3 0 3	0 0 0	
0	0 0 0	0 0 0	0 0 0	0 0 0	
-	-2 0 2	-1 0 1	3 0 -3	0 0 0	
States:	↓	↓	↓	↓	↓
Balance:	-5 0 5	-1 0 1	1 0 -1	2 0 -2	-3 0 3
Maxima:	↑	↑	↑	↑	↑

1. Consistency / inconsistency

The consistency score (and its pendent, the inconsistency score) is the most important key figure for CIB scenarios. It can be generated for every conceivable scenario (whether consistent or inconsistent) and the result determines whether the scenario is accepted as a solution of the CIB matrix ("consistent scenario") or rejected as an "inconsistent scenario".

[1] Information on CIB and handouts on how to apply the method can be found at www.cross-impact.de

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[3] Available from www.cross-impact.de (Guidelines section)

The consistency score can be calculated out of the impact balances of the scenario in question depicted in the illustration above. For every descriptor the difference between the impact score of the state selected and the maximum impact score of its competing states is then calculated. The test scenario produces the following differences

[5, 1, 1, -4, 3] .

These are the **consistency scores of the individual descriptors** in case of the test scenario (descriptor consistency scores, not to be confused with the scenario consistency score). For Tom the impact score for the state selected (Tom disagrees) is 5, while the best alternative state (Tom is undecided) produces a 0. The difference is therefore 5 - 0 = 5. For Katja the selected state (Katja disagrees) produces an impact score of -2, while the best alternative state (Katja agrees) bears an impact score of +2. The difference, i.e. the logical disadvantage of the selected state when compared with the best alternative hypothesis is therefore -2 - (+2) = -4.

The minimum of the individual descriptor consistency scores is taken as the **consistency score for the entire scenario**. The minimum (rather than the average value, for instance) is pivotal, since a scenario, just like an argument or line of evidence, must be rejected if it demonstrates a single weakness in its logic. As soon as a single link is broken the value of all other stages in the chain of evidence is condemned as insignificant. The judgement of CIB scenarios follows the same principle: it focuses on the weakest link.

The test scenario is therefore allocated a consistency score of -4. And is thus inconsistent. Consistent scenarios produce a consistency score of 0 or above.

The **inconsistency score** of a descriptor and/or scenario respectively assumes this score in reverse. Hence a scenario with a consistency score of -4 has an inconsistency score of 4. By convention inconsistency scores are not given negative values, i.e. a scenario with a consistency score of +1 has an inconsistency score of 0, simply expressing that there are no inconsistencies at all in the scenario. The same applies to descriptor inconsistency scores: positive descriptor consistency scores equate to descriptor inconsistency 0. Inconsistency scores do not contain any new information, they simply offer an additional linguistic option, which avoids the use of negative values in the case of inconsistent scenarios[4].

If a CIB matrix has several consistent scenarios and if these differ in terms of consistency scores, this may be regarded as indicative of their varying degrees of robustness against perturbations. Characteristic of consistent scenarios with a consistency score > 0 is the fact that no single minor alteration in the allocation of points within the matrix (whether owing to the correction of an incorrect judgement or the idea that additional external factors interfere with said system) can call into question the fundamental consistency of said scenario. The higher a scenario's consistency score, the greater the degree of change it can withstand – even at critical points of the cross matrix - without becoming inconsistent.

With regard to possible misjudgements or potential interference stemming from parameters unaccounted for in the analysis, it can make sense – in addition to the consistent scenarios - to examine scenarios demonstrating moderate inconsistency. Among other cases, this approach is frequently employed in cases in which a CIB matrix produces no absolutely consistent scenarios, in order to identify the most potentially credible scenario hypotheses. When using the *SzenarioWizard*[5] software the "analysis options" window offers the possibility of conducting a scenario search using a tolerance which can be specified for weak inconsistencies. If weak inconsistent scenarios do not exist either it should be considered whether the system would not be better characterised using non-stationary scenarios, i.e. those cyclical solutions identified by *ScenarioWizard*.

[4] In addition to the type of inconsistency calculus described here ("local inconsistency"), „global inconsistency" also exists which not only uses the most inconsistent descriptors for orientation, but also includes all the inconsistent descriptors of the scenario in question (cf. Weimer-Jehle 2006). For the reasons outlined above, the software *ScenarioWizard* applies the concept of local consistency assessment as described here.

[5] The software is available free of charge from the method homepage www.cross-impact.de.

2. Total Impact Score

The total impact score of a scenario consists of the sum total of all impacts of all selected states. In the example on page 1 the impact total is

$$5 + 1 + 1 - 2 + 3 = +8$$

Once again it is possible to calculate the total impact score for all scenarios (consistent or inconsistent). While the consistency score assesses scenarios "locally" according to their weakest link, the total impact score supplements this judgement with a "global" assessment – i.e. inclusive of the entire scenario. Scenarios of a higher consistency tend towards a relatively total impact score, nevertheless this association is not absolute, which is why the total impact score is of particular benefit as an additional key figure.

The consistency score is crucial to the analysis of a scenario, which is why the total impact score is generally only consulted when examining scenarios with the same consistency score. In a group of scenarios with the same consistency, the total impact score can be used to ascertain which of them features the greatest degree of logical robustness.

The total impact score plays a special role in the unusual event of symmetrical CIB matrices, which sometime occur in particular types of scenario analysis. In the case of symmetrical CIB matrices, the scenarios with maximum total impact score are always consistent (Weimer-Jehle, 2009), which is not something that applies in general.

References:

Weimer-Jehle W. (2006): Cross-Impact Balances: A System-Theoretical Approach to Cross-Impact Analysis. Technological Forecasting and Social Change, 73:4, 334-361.

Weimer-Jehle W. (2009): Properties of Cross-Impact Balance Analysis. arXiv:0912.5352v1 [physics.soc-ph].

The series "Cross-impact balance analysis guidelines" provides information and assistance for the implementation of scenario and systems analyses using the CIB method. In addition to a description of the basics and information on the method's background the series also includes instructions on its application, procedural descriptions and sample analyses. Publications to date:

No.	Title	Requirements
1	Introduction to qualitative systems and scenario analyses using cross impact balance analysis	none
2	Bibliography	no. 1
*3**	*Sample instructions for experts on issuing cross-impact judgements*	*no. 1*
4	Key figures used in the analysis of CIB scenarios	no. 1

* *in preparation*