Collaborative Building of an Ontology of Key Performance Indicators

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Abstract. In the present paper we propose a logic model for the representation of Key Performance Indicators (KPIs) that supports the construction of a valid reference model (or KPI ontology) by enabling the integration of definitions proposed by different engineers in a minimal and consistent system. In detail, the contribution of the paper is as follows: (i) we combine the descriptive semantics of KPIs with a logical representation of the formula used to calculate a KPI, allowing to make the algebraic relationships among indicators explicit; (ii) we discuss how this representation enables reasoning over KPI formulas to check equivalence of KPIs and overall consistency of the set of indicators, and present an empirical study on the efficiency of the reasoning; (iii) we present a prototype implementing the approach to collaboratively manage a shared ontology of KPI definitions.

1 Introduction

Modern networked business paradigms require models offering a common ground for interoperability and collaboration. Reference models have been established for supply chains and other networked organizations [1,2], that include the description of business processes structure and performances as described in a library of Key Performance Indicators (KPIs). These models are typically built as a “consensus view” over the partners’ own views, which is reached mostly by human interaction. In the present paper we propose a logic model for the representation of Key Performance Indicators (KPIs) that supports the construction of a valid reference model (or KPI ontology) by enabling the integration of definitions proposed by different engineers in a minimal and consistent system. The approach is characterised by the representation of what we call the compositional semantics of KPIs, i.e. the meaning of KPIs is composed from the meaning of their subparts. As a matter of fact, KPIs are measures generated by means of operations like aggregation and algebraic composition. The aggregative structure of KPIs is captured by the multidimensional model [3], whose formalization is well studied in the Literature. The composite structure of KPIs refers to the calculation formula by which an indicator is calculated as a function of other
indicators, for instance in the form of a ratio (e.g. the acceptance rate, or the ratio between income and investments, known as Return On Investment or ROI). The starting point of the paper is that the composite structure of an indicator is at least as fundamental as aggregation to capture its semantics, and deserve special attention.

To illustrate and motivate the approach, let us consider a scenario where a shared dictionary of KPIs is collaboratively managed. Knowledge Engineers and Performance Managers belonging to networked organizations decide to collect KPI definitions for future reference use or for interoperability purposes. Each autonomous entity proposes KPI terms, definitions and properties, then a consensus is achieved in order to decide the dictionary entries. Some typical use cases can be recognised in this process:

– Check of KPIs’ identity: this activity allows to establish if a KPI at hand already exists in the dictionary. Two KPIs can be defined to be identical if they provide the same value for the same real phenomenon, expressed by some transactional data. Then, although a “sameAs” relationship can be established by analysing terms and definitions, the ultimate semantics of the indicator is given by its calculation formula.

– Introduction of a new KPI: this is the basic activity allowing the incremental building of the dictionary. Inserting a new KPI should not introduce inconsistencies in the dictionary, hence this activity is naturally related to consistency checking and enforcement mechanisms. For instance, trivial inconsistency can be generated when introducing the income defined as the ratio between ROI and investments, when the ROI definition, as given before, already exists in the ontology.

– Update and deletion of existing KPIs: as the result of coordination and cooperation, KPIs introduced by a single entity can be revised or even deleted from the dictionary. Update and deletion require proper mechanisms for inconsistency management as above.

– Browsing: it is the fundamental activity for the analysis of KPI properties.

– Searching: a dictionary is typically explored to look up KPI definitions. Smart search engines allow to quickly check the existence of a KPI. Besides traditional keyword-based search, the structure of the formula can be used as a key for searching.

– Consensus management and versioning: it refers to the organization of collaborative work, in particular mechanisms for the convergence towards a common uniform view and for tracing and roll-back of previous work.

In this scenario, the proposal of the present paper is to provide advanced support for the above mentioned use cases by leveraging on the representation and manipulation of the formula defining a KPI. In particular, the original contributions of the paper are:

– we combine the descriptive semantics of KPIs with their compositional semantics into an ontology called KPIOnto. The ontology introduces a logical representation of KPIs and their formulas, allowing to make the algebraic relationships among indicators explicit;