

An Approach to Forming Dashboards for Business Process Indicators Analysis using Fuzzy and Semantic Technologies

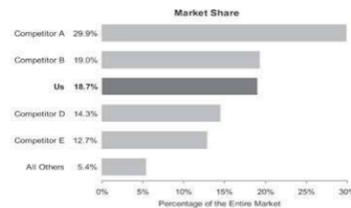
Andrii Kopp and Dmytro Orlovskiy

National Technical University “KhPI”, Kharkiv, Ukraine

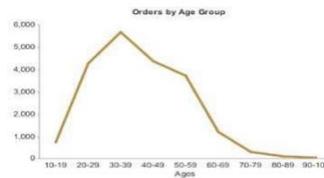
Visualization of business performance using KPIs and BI dashboards

Visualization tools^[1]:

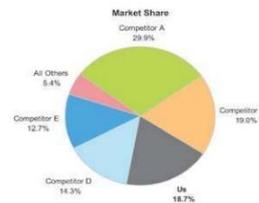
- Bar chart



- Line chart



- Pie chart



- Gauge



KPIs types^[2]:

- Quantitative

(displays the comparable components of the vector value effectively)

- Directional

(displays the direction of change of the scalar value)

- Category

(displays the vector value, which components represent parts of a 100%)

- Actionable

(displays the scalar value, which goes up or down beyond a target value)

1. Eckerson, W., Hammond, M.: Visual Reporting and Analysis: Seeing Is Knowing: Asset Page. (2011).
2. Management Reports & Dashboard Best Practice. <https://www.targetdashboard.com/site/kpi-dashboard-best-practice>

KPIs dashboard design problem

requires placing various visualization tools in a small place, while keeping them accessible and easy to understand^[1].

Besides that business requirements for visualization tools set may change in time.

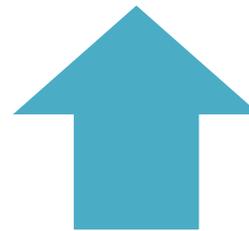
Why it should be formalized?



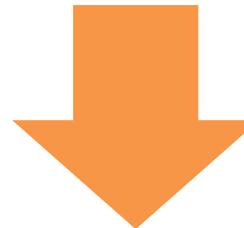
While being clear,
easy interpretable,
and attractive



visualization tools
should be space
efficient and
legible



Despite various
recommendations for
visualization tools
usage



dashboard design
depends on
individual user's
preferences

1. Few, S.: Information dashboard design. (2006).

Relations between KPIs, KPI types, and visualization tools

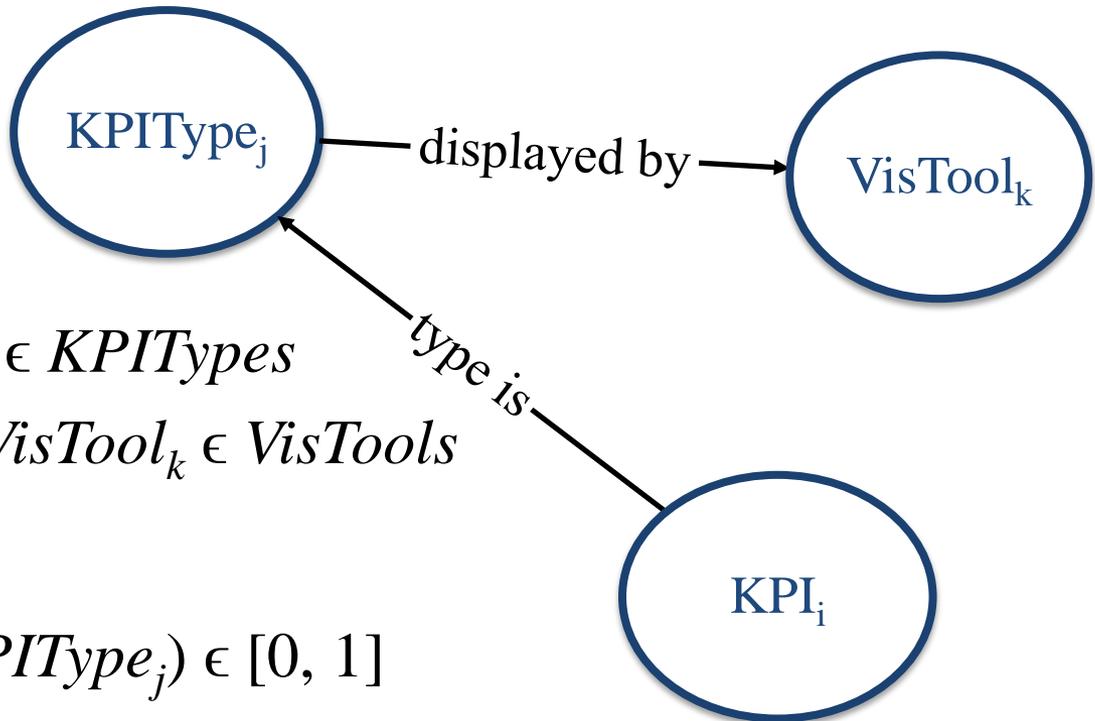
could be represented using a fuzzy semantic network^[1].

Concepts:

- KPIs, $KPI_i \in KPIs$
- KPI types, $KPIType_j \in KPITypes$
- Visualization tools, $VisTool_k \in VisTools$

Fuzzy relations:

- “type is”, $\mu(KPI_i, KPIType_j) \in [0, 1]$
- “displayed by”, $\mu(KPIType_j, VisTool_k) \in [0, 1]$



1. Dash, S., Subudhi, B. (eds.): Handbook of Research on Computational Intelligence Applications in Bioinformatics. (2016).

Business Process Management (BPM) system's event log processing

Event structure^[1]: $event = (eventID, caseID, KPI_i, timeStamp, e_{val}, KPIType_j)$,

$eventID$ – the unique identifier of the event;

$caseID$ – the unique identifier of the business process instance;

$timeStamp$ – the timestamp of the event occurrence;

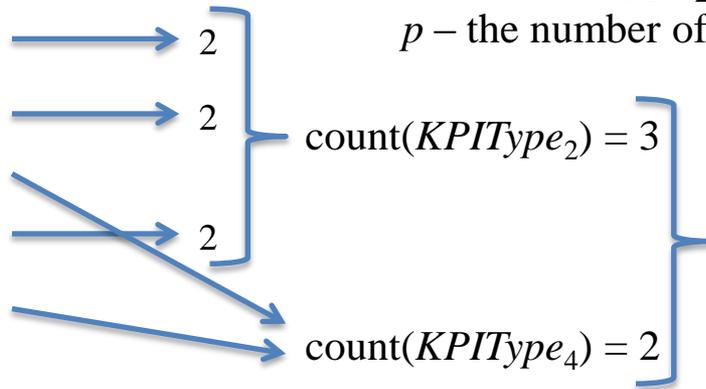
e_{val} – the value of KPI_i .

How to define the membership function of the fuzzy relation “type is”?

eventID	kpiID	kpiTypeID
1	1	2
2	1	2
3	1	4
4	1	2
5	1	4
6	2	1

$$\mu(KPI_i, KPIType_j) = \text{count}(KPIType_j) / \max\{\text{count}(KPIType_1), \text{count}(KPIType_2), \dots, \text{count}(KPIType_p)\},$$

p – the number of types, related to the KPI.



$$\begin{aligned} \mu(KPI_1, KPIType_4) &= \\ &= 2 / \max\{3, 2\} = \\ &= 2 / 3 \approx 0,67 \end{aligned}$$

1. Weidlich, M., Ziekow, H., Mendling, J., Günther, O., Weske, M., Desai, N.: Event-based monitoring of process execution violations. (2011).

Solution of the KPIs dashboard design problem. Part 1

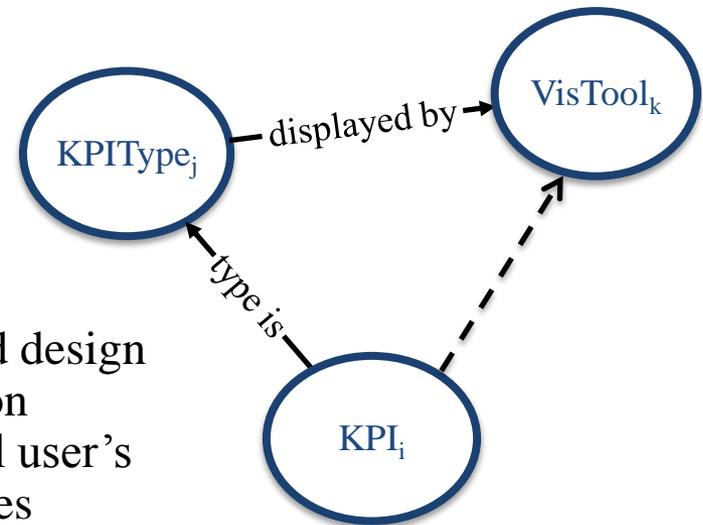
- Values $\mu(KPIType_j, VisTool_k)$ depends on individual user's preferences.
- Values $\mu(KPI_i, KPIType_j)$ depends on the BPM system's event log content.
- The relation between KPIs and visualization tools as the max-min composition of fuzzy relations “type is” and “displayed by”:

$$\mu(KPI_i, VisTool_k) = \max\{\min\{\mu(KPI_i, KPIType_j), \mu(KPIType_j, VisTool_k)\}\}.$$

The membership function of the fuzzy relation between KPIs and visualization tools may be influenced by the event log's content, as well as the user's preferences.



dashboard design depends on individual user's preferences



Solution of the KPIs dashboard design problem. Part 2

How to define the set of visualization tools, used to build the dashboard?

s_k – the preferable part of the dashboard’s space, where the visualization tool $VisTool_k$ should be placed;

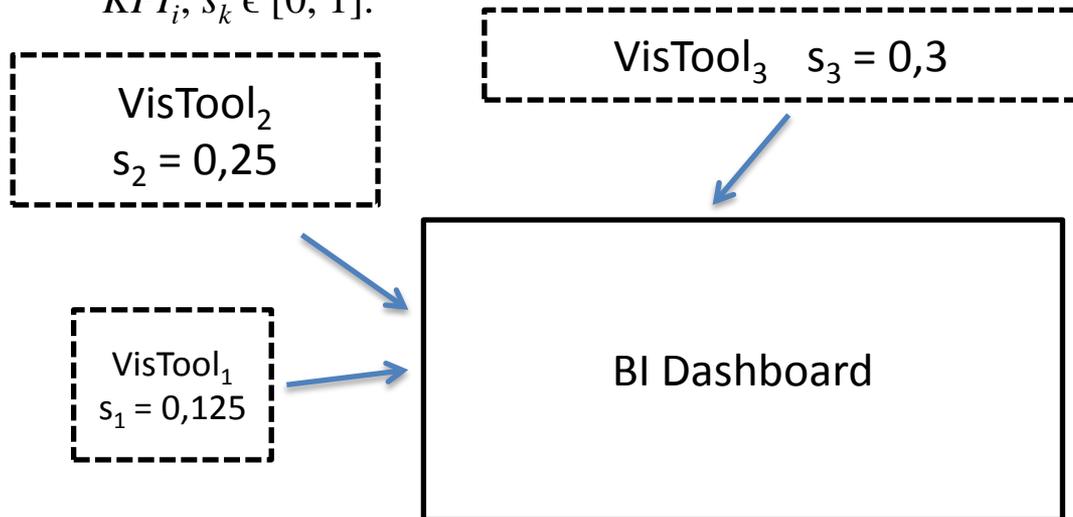
$$\sum_{i=1}^n \sum_{k=1}^q \mu(KPI_i, VisTool_k) \cdot x_{ik} \rightarrow \max,$$

x_{ik} – the binary value, that demonstrates whether the visualization tool $VisTool_k$ is selected to represent the KPI_i ; $s_k \in [0, 1]$.

$$\sum_{k=1}^q x_{ik} = 1, \forall i \in \overline{1, n},$$

$$\sum_{i=1}^n \sum_{k=1}^q s_k \cdot x_{ik} \leq 1,$$

$$x_{ik} \in \{0,1\}, \forall i \in \overline{1, n}, \forall k \in \overline{1, q},$$



visualization tools should be space efficient and legible

Sample business process: Product supply

KPIs of the product supply process, according to the Supply-Chain Operations Reference (SCOR) model^[1]:

- Orders Supplied in Full (OSF_%)
- Cost to Supply (CS)
- Supply Cycle Time (SCT)

The example values of membership function of the fuzzy relation “type is”

$\mu(KPI_i, KPIType_j)$	Quantitative	Directional	Category	Actionable
OSF _%	0,42	0,17	0,08	1,00
CS	1,00	0,75	0,25	0,50
SCT	0,67	1,00	0,33	0,22

1. Kopp, A. M., Orlovskiy, D. L., Kuka, D. O.: An approach to forming dashboards for business processes state analysis. (2017)

Obtaining recommendations for the dashboard's design

The example values of membership function of the fuzzy relation “displayed by”

$\mu(KPI_{Type_j}, VisTool_k)$	Gauge	Pie chart	Line chart	Bar chart
Quantitative	0,38	0,38	0,75	1,00
Directional	0,20	0,20	1,00	0,60
Category	0,57	1,00	0,86	0,43
Actionable	1,00	0,22	0,22	0,78

As a result, the values of membership function of the fuzzy relation between KPIs and visualization tools:

$\mu(KPI_i, VisTool_k)$	Gauge	Pie chart	Line chart	Bar chart
OSF _%	1,00	0,38	0,48	0,78
CS	0,50	0,38	0,75	1,00
SCT	0,38	0,38	1,00	0,67

The example sizes of *VisTools*:

$VisTool_k$	s_k
Gauge	0,125
Pie chart	0,25
Line chart	0,50
Bar chart	0,375

Optimization problem solution:

x_{ik}	Gauge	Pie chart	Line chart	Bar chart
OSF _%	1	0	0	0
CS	0	0	0	1
SCT	0	0	1	0

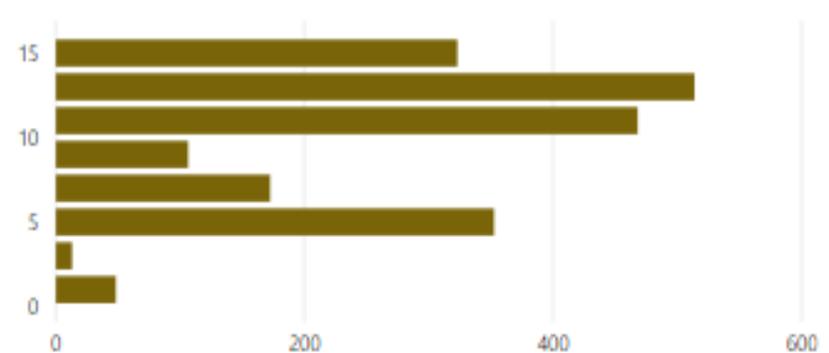
Possible dashboard design

- Use the gauge to represent OSF (up to 12,5% of the dashboard space)
- Use the bar chart to represent CS (up to 37,5% of the dashboard space)
- Use the line chart to represent SCT (up to 50% of the dashboard space)

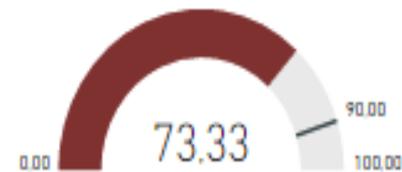
Supply Cycle Time



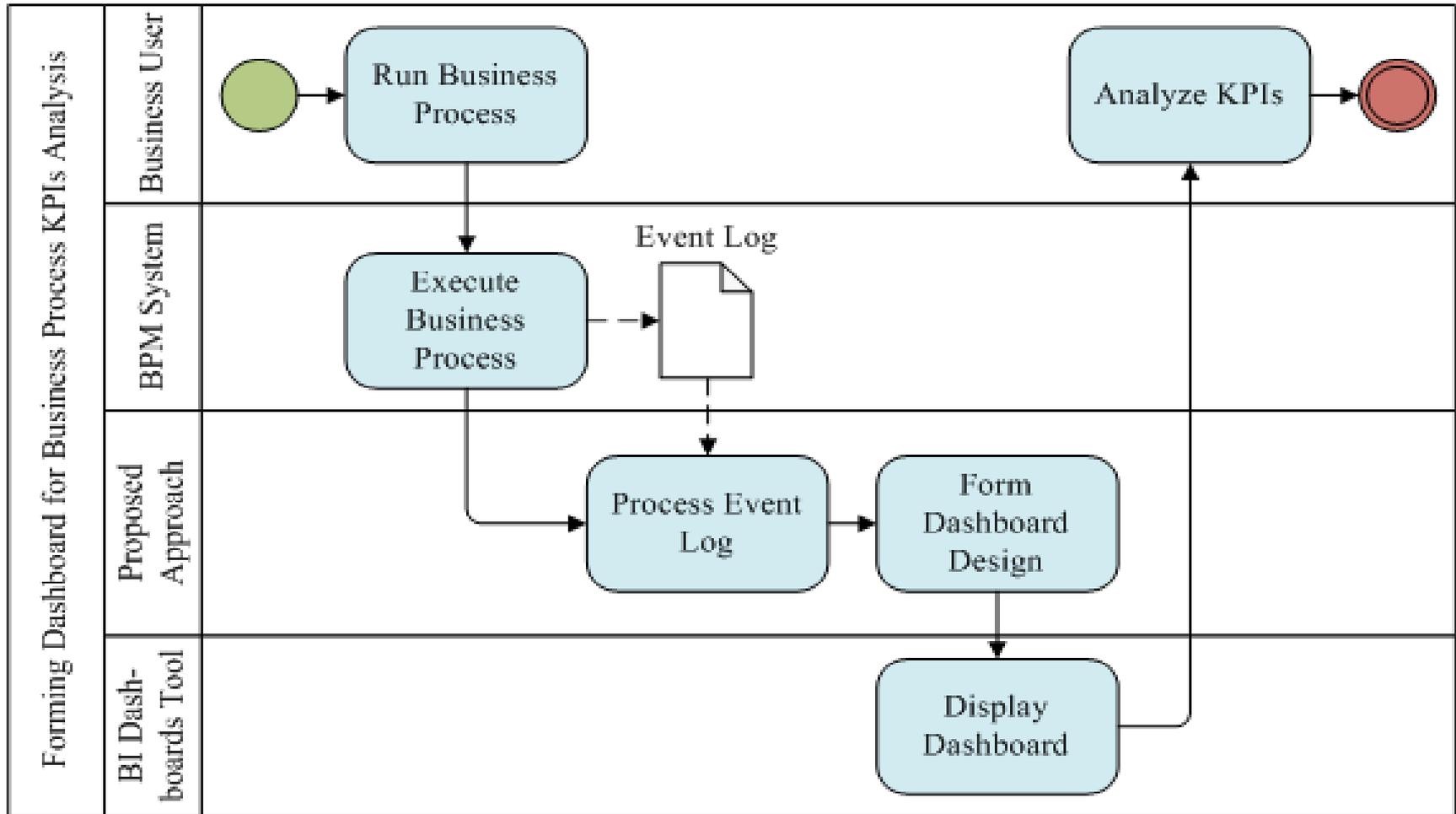
Cost to Supply



Orders Supplied in Full



Workflow scheme of forming dashboard for business process KPIs analysis



Conclusion and future work

- The KPIs dashboard design problem has been formalized, as well as the approach to forming dashboards has been proposed
- The approach considers the impact of relations between KPIs, KPI types, and visualization tools
- Application of fuzzy semantic network is used to describe and analyze these relations
- The optimization problem used to obtain recommendations for the dashboard's design has been proposed
- Additional considerations on the dashboards design
- Keeping its history of changes traceable and accessible for the further analysis
- Selection of BPM system and BI dashboards tool to be customized and integrated
- Implementation and application of the proposed approach
- Obtained results analysis and discussion

Thank you!