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THE SUPPORT OF HUMAN FACTORS FOR ENCOMPASSING BUSINESS INTELLIGENCE

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ABSTRACT

Aim/Purpose	This paper attempts an inquiry into some Business intelligence (BI) implementation challenges related to human factors, and uses empirical survey data to test how the required BI coverage relates to perceived level of BI culture through such important human factors in BI as information sharing.
Background	Business intelligence adoption already has a formidable body of experience, yet confusion remains over several key issues – implementation, adoption, created value. The multidimensionality of BI both in business dimensions and implementation dimensions is intended to handle the information integration requirements to produce an overarching view of business environment. The importance of human factors in utilizing BI potential lately has drawn growing attention of researchers, concentrating on such issues as information and insight sharing, emergence of intelligence community, preservation of experience.
Methodology	An empirical survey of BI users, and analysis by data mining tools to disclose the strength of relationships between human factors and perceived levels of BI culture.
Contribution	The paper points out the most prominent features of BI culture, and investigates their influence on perceived levels of BI culture.
Findings	The results of the survey confirm that the dominating share of the respondents are well aware of BI culture, and perceive its level above mediocre. The results also support the existence of variety of delivery modes for BI results, prevalent need for information from other departments for insight development, and multiple modes of information sharing across functional borders. Respondents who are the most satisfied with their BI culture treat information sharing as one of the key features of intelligence environment.
Recommendations for Practitioners	The named features of BI culture may be projected against real situation to assist evaluation of BI implementation potential and required action.

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Recommendation for Researchers	The cultural specifics of intelligence activities may be considered when investigating BI implementation issues.
Impact on Society	Better understanding of activities in informing, and especially advanced informing.
Future Research	Some issues that clearly merit further inquiry are information integration, insight development, issues of BI dimensions and agility.
Keywords	business intelligence, business intelligence culture, information and insight sharing

INTRODUCTION

Business intelligence (BI), as a distinct kind of informing activities, is obviously past its turbulent growth as a fresh concept. However, its importance for well-informed activities and insight development is hardly questionable. BI adoption already has a formidable body of experience, yet confusion remains over several key issues – implementation, adoption, created value, to name a few. The complexity of intelligence information needs aims at the levels of sense-making that support the development of insights; it can be stated that insights are the main product of BI. For these purposes, any available useful information source and processing tool will be used. This leads to the complexity and variety of intelligence activities.

For the goal of insight development, an important feature of BI is multidimensionality, which extends from basic figures and facts to meaning-rich contexts (Warner, 2014), from monitoring of everyday operations to the analysis of large one-of-a-kind problems (Davenport, 2015; Kamal, 2012), from internal efficiency to wide-ranging strategic insights (Dykes 2016). This provision of multiple dimensions and heterogeneous views leads to a more complete understanding about activities, opportunities and risks, and valuable insights may emerge as a result. Unlike traditional management information systems, who operate in fairly defined functional areas, business intelligence often has to provide a composite view of a field of interest, combining data and information from various channels in assorted formats, produced using different conventions and possessing uneven reliability. While data integration has many its technical problems solved, information integration revolves around different principles – relations are created by tokens of sense, not data serving as keys between tables or other data collections. Use of IT for information integration is complicated by the fact that sense handling by IT is still in its infancy.

A certain business situation that requires an important decision to make will have its set of the most important dimensions that, if properly evaluated, provide the basis for a quick and reliable estimate to act upon. Examples of such dimensions may be:

- Financial strength – good or weak;
- Team and people quality – strongly or weakly motivated;
- Client relations – profound or superficial;
- Competitive strength – strong player, small player, niche player etc.;
- Resource use – strained versus relaxed;
- Opportunity field – numerous versus few;
- Innovativeness – innovator versus follower; etc.

The above dimensions, because of their importance, need a reliable assessment; arguments for such assessment are well discussed in Ramakrishnan, Jones, and Sidorova (2012) and are targeted towards producing a single consistent version of business information. For these dimensions to be seen and evaluated together as a whole, many technological issues have to be solved, like information integration from different sources, integrated presentation in form of graphs and dashboards, flexible soft-

ware for dimension manipulation, to name a few. Such issues lead to BI implementation options and technology dimensions that should support the required flexibility along business dimensions. Elliott (2004) has proposed a set of several dimensions along which BI is implemented:

- **Functional complexity and ease of use: s**ome products provide more sophisticated functionality than others.
- **Data depth:** level of detail, data granularity.
- **Data breadth:** information integration across different systems to perform cross-functional analysis.
- **User control:** direct autonomous access, or user pull, as opposed to specially prefigured and delivered content, or system push.
- **Business specialization:** narrow scope content for a specific function or business domain, as opposed to wide scope content encompassing key functions or processes.

A related set of BI implementation dimensions has been proposed in Skyrius (2015): internal and external focus; centralized and decentralized placement; wide coverage versus narrow; data driven (system push) versus insight-driven (user pull); real time versus right time. Such dimensions are important when available resources are limiting the scope of a BI system, and the positioning of BI functions along these dimensions that should provide the most coverage and flexibility depends on the nature of business activities. In any case, the system is expected to provide a single consistent view of business environment.

In the complex informing process that is employed by BI, the key business dimensions need to have reference points, often in the form of key performance indicators, or KPI. The implementation of such standards is meant to unify the most important business metrics; according to Ramakrishnan et al. (2012), one of the reasons organizations implement BI is to achieve a single consistent view of business information. Standards for important business dimensions provide better awareness of the positioning of business, either for regular activities or transformation. The benefits of such unification are obvious: a more reliable support for decision making; better data quality; facilitation of communication between internal stakeholders.

Alongside the single source of truth (SST) as an important set of technical and managerial standards, for a consistent view that can be trusted no less important is communication between stakeholders within organization. While standards and SST serve as a common denominator for integration and sharing of information, at the same time communication and sharing may positively influence the quality and completeness of standards by facilitating detection of discrepancies and insight development. Davies (2004) has stressed the importance of communication and information sharing by showing the need to utilize diverse information sources and to meld received fragments of information into a coherent picture as a basis for sound decisions. The same point is supported by Zack (2007): "regardless of how information technology is applied, organizations must provide ample opportunity for interpersonal interaction and shared experience to build the social relations and communication mechanisms to allow deep knowledge to be exchanged and developed."

RELATED WORK

Although the initial surge of interest in BI is well past its peak, it can be expected that BI systems will further maintain the principal function of providing the users with required meaningful information at required time and in required place. Same can be said about the role of any information system, but BI usually considers information needs that range in their complexity levels from medium to high. The purpose of BI, according to various sources, is thorough, complete and actionable informing by covering many important information needs:

- decision-making (Arnott & Pervan, 2014; Evelson, 2010; Imhoff & White, 2008; Meredith, Remington, O'Donnell, & Sharma, 2012; Rouibah & Ould-Ali, 2002; Watson & Wixom, 2007);
- gathering and analysis of business information (Riabacke, Larsson, & Danielson, 2011);
- insight development (Atre, 2004; Evelson, 2010; Meredith et al., 2012);
- a comprehensive view of activities and environment (Ramakrishnan et al., 2012; Sabherwal, & Fernandez, 2011).

A literature analysis of research on BI success, performed by Villamarin Garcia and Diaz Pinzon (2017) has resulted in a list of success criteria where human and managerial criteria prevail. Powell (2009) has pointed out that important issues for insights are having good data, smart people, and a structure or culture that increases the action potential of insights. Other research on human factors has highlighted:

- Information behaviors and values (Marchand, Kettinger., & Rollins, 2001);
- Creativity and original thinking (Fleischer, 2008);
- BI adaptation cues based on human factors (Presthus, 2014);
- Social influence and learning climate (Yoon, Ghosh, & Jeong, 2014);
- Critical success factors for BI implementation, where organizational and managerial dimensions prevail (Yeoh & Coronios, 2010; Yeoh & Popovic, 2015);
- Managerial factors dominating BI business benefits (Olszak 2016).

HUMAN FACTORS AND ROLE OF INTELLIGENCE CULTURE

As stated above, the importance of human factors in BI is largely conditioned by the fact that information technology alone cannot solve the variety of issues of BI information integration to produce expected insights. It is hardly possible to have a system encompassing this complexity and variety. An emerging trend, although mentioned several years earlier, is the development of specific business intelligence culture as a unifying environment for human drivers and a key prerequisite for successful adoption. The issues of business intelligence culture are still lacking structure and clarity; however, several groups of culture features are starting to emerge.

The use of a vague term "culture" is somewhat risky, yet there are numerous works assigned to organizational culture as one of the important features of organization. Less attention has been given to information culture, although there is considerable research (e.g., Choo, 2013; Hoglund, 1998) aimed at definition of information culture and its relation to organizational culture. The intent to use "intelligence culture" as one more term in the information management field may provoke discussion, yet the authors believe that information culture and intelligence culture are not exactly the same, and there are important differences between the two. For example, the scheme proposed in (Choo, 2013) for defining types of information culture is well-argumented, yet it does not include compartmentalization and silo culture, which is a rather important obstacle in intelligence activities. Information culture aims at the use of all information at all levels, while intelligence culture deals with complex information needs that arise from important and possibly costly issues, and intends to use advanced information management.

The set of the most important features of intelligence culture has been described in Skyrius et al. (2016); encompassing the emergence of intelligence community that shares information and insights, it is motivated to grow, capture and preserve experience and is supported by an appropriate IT platform. These features are reminiscent of knowledge management (KM) systems proposed in the last couple of decades, but there are important differences – business intelligence, and intelligence in general, deals mostly with advanced *information* management, and as a field is much more mature with a significantly larger body of experience.

The experience with intelligence communities (Pillar, 2011; Snow, 2014) has shown that sharing activities or, even better, their self-sustained growth is largely driven by motivation to share and contribute, especially when the value of sharing is explicitly demonstrated. According to Hoglund (1998), it is not possible to deliver required system quality if the communication between individuals, teams and departments does not work.

To gain more understanding of how the important features of information activities affect intelligence culture, an empirical research has been planned to gain responses from business professional dealing with BI activities.

DATA ANALYSIS

A survey has been performed among 207 business representatives – mostly middle-level managers that are BI users. The respondents have been asked to indicate their perceived level of BI culture in their organizations on a 5 degree Likert scale, value 1 being the lowest rating, and 5 – the highest. Perceived intelligence culture level here serves as one of the indicators of value that users assign to existing BI system.

The most important issue for data analysis below is the relation between features of BI with the levels of perceived BI culture that are above average (3 and more). We do not necessarily equate higher level of perceived BI culture to a higher phase of BI maturity, partly because we believe a number of suggested BI maturity approaches and models are misleading, and also we do not believe BI culture relates to phases in time. To our opinion, it is more like a relation to a certain type of corporate of organizational culture, which may be rather mature in its own way, but not necessarily in sync with features of BI culture.

The survey has contained several questions related to the horizontal communication between people involved in business intelligence activities:

- Q11: how intelligence reports are prepared?
  - on one's own, or by users themselves;
  - data renewed automatically;
  - produced on request by analysts, IT staff, subordinates;
  - other.
- Q12: In what cases analysis requires information from other processes or departments?
  - in all cases;
  - only when a problem occurs;
  - does not require;
  - don't know.
- Q13: – How do you access the required decision information from other departments?
  - Self-service – myself, having access rights;
  - other department provides on my request;
  - executed by BI representative (BI ambassador) on request;
  - the process is unregulated and chaotic;
  - no such need.
- Q15: – How people share analytical insights inside organization?
  - do not share;
  - only during common meetings;
  - on permanent basis by direct communication and self-initiated discussions;
  - don't know;
  - other.

The role of the dependent variable has been assigned to the perceived level of intelligence culture inside an organization, indicated in question Q23. The distribution of responses to Q23 is presented

in Table 1. We have to note that the absolute majority of respondents (165 out of 207, or 79.7%) consider their organizations having their level of intelligence culture at 3 (mediocre) or 4 (good). As no additional explanation for this estimate has been elicited in the survey, we can only assume that the relative reluctance to indicate a maximum level of intelligence culture can be explained by awareness of ever-present deficiencies in BI activities. Following this assumption, the most realistic favorable estimate of BI activities is 4 – "Good".

Table 1. Distribution of the perceived level of intelligence culture (Q23)

Perceived level of intelligence culture	Number of cases
1	3
2	18
3	86
4	79
5	21
Total:	**207**

Among the indicated reasons for complicating the implementation of BI (Table 2), the top 5 reasons point to the cases where BI is not appropriately valued, and there is a lack of leadership that can be attributed to BI culture.

Table 2. Top reasons for complicating the implementation of BI

Reason	Count
Lack of BI ambassador	24
Employee understanding of BI benefits	16
No BI strategy	15
Absence of local project manager	15
Ownership dilema	14
Data quality	14
Lack of standards and SST	13
System incompatibility	12
Unstructured and chaotic processes	11
Mismatch between BI and company strategies	10
Local Project manager inadequacy	9
Critical delay of data entry	8

The further analysis of data has been performed using IBM SPSS Modeler 17.1 data mining software. The relation between perceived level of BI culture and instances for chosen questions Q11, Q12, Q13 and Q15 has shown varying strength of relation, and the most supported rules where both support and confidence levels are above or close to 50 percent are shown in Table 3.

Table 3. The most supported rules between levels of perceived BI culture and questions Q11, Q12, Q13, Q15

Perceived level of BI culture (Q23)	Question instance	Support	Confidence	Comment for question instance
4	Q11 = KB	51,208	44,34	How intelligence reports are prepared? – Several modes of intelligence report delivery
4	Q12 = NU	48,309	43	In what cases analysis requires information from other processes or departments? – In all cases
3	Q15 = KB	41,546	46,512	How people share analytical insights inside organization? – During common meetings
4	Q15 = KN	49,758	45,631	How people share analytical insights inside organization? – On permanent basis by direct communication and self-initiated discussions

The results implicate that for higher levels of perceived BI culture information sharing between participants of BI activities is a common and valued process. For further checking of the results, two additional steps of analysis have been taken:

- a SPSS V.25 neural network analysis has been performed on the survey data, evaluating the Q23 (perceived level of BI culture) prediction strength by responses to questions Q11, Q12, Q13 and Q15; and
- a web diagram analysis has been executed on the survey data regarding relations between question Q23, and questions Q13 "How information from other departments is accessed?" and Q15 "How people share analytical insights inside organization?"; these questions have been selected as the ones most reflecting information sharing practices.

Neural Network Analysis

The analysis procedure, including questions Q11, Q12, Q13 and Q15 as predictor variables for Q23, had generated a network with single hidden layer containing a single node. The results of analysis are presented in Table 4.

The results indicate that both for training and testing stages the strongest prediction levels lie in the area of Q23 values of 3 and 4. This can be explained by the domination of these values in survey responses. The overall prediction strength is lower – 51.0% for testing stage, and 42.6% for testing stage; this setback can be explained by lesser frequencies of other instances for Q23.

Table 4. The results of neural network analysis for prediction of Q23 – The perceived level of BI culture

Sample	Observed	Predicted					
		1	2	3	4	5	Percent correct
Training	1	0	0	1	0	0	0,0%
	2	0	0	12	3	0	0.0%
	3	0	0	38	22	0	63.3%
	4	0	0	20	36	0	64.3%
	5	0	0	5	8	0	0.0%
	Overall percent	0.0%	0.0%	52.4%	47.6%	0.0%	51.0%
Testing	1	0	0	2	0	0	0.0%
	2	0	0	3	0	0	0.0%
	3	0	0	15	10	0	60.0%
	4	0	0	12	11	0	47.8%
	5	0	0	4	4	0	0.0%
	Overall percent	0.0%	0.0%	59.0%	41.0%	0.0%	42.6%

WEB DIAGRAM ANALYSIS

For **question Q13 "How information from other departments is accessed"**, multiple responses were allowed. The count of instances of all possible responses is given below in Table 5.

Table 5. Instance count for responses to question Q13

Instance of a response	Count
Self-service – myself, having access rights	107
Other department provides on my request	99
Executed by BI representative	50
No such need	24
The process is unregulated and chaotic	19
Other	5

The question Q13 allowed multiple instances of responses; to evaluate the possible most frequent combinations of instances, a binary code has been used, as shown in Table 6:

Table 6. Coding of most frequent responses to question Q13: "How information from other departments is accessed"

Self-service, having access rights	Other departments provide on request	Executed by BI representative (BI ambassador) on request	The process is unregulated and chaotic	No such need	Code
0	1	0	0	0	8
1	0	0	0	0	16
1	1	0	0	0	24

The web diagram of strongest relations between instance of Q13 and Q23 is presented in Figure 1.

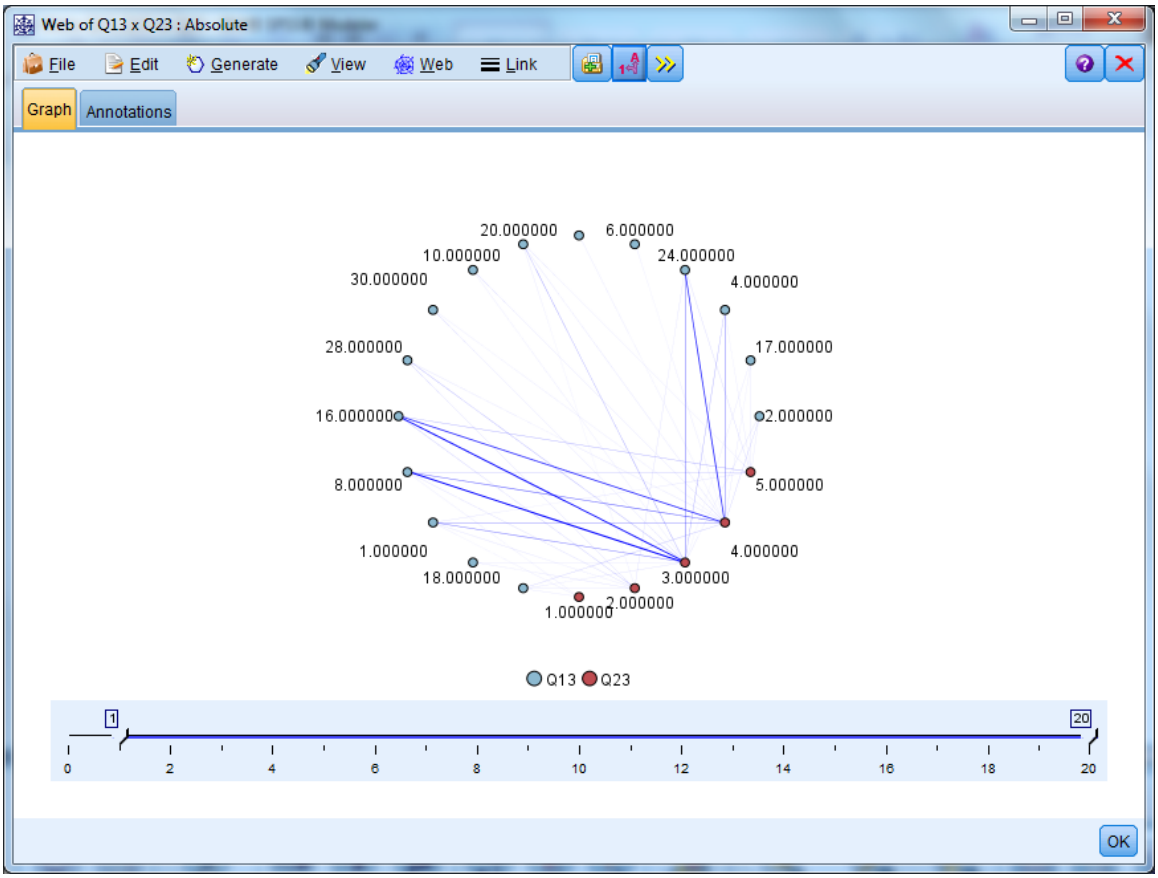

Figure 1. Relations between instances of Q13 and Q23

The most frequent relations in this pair are shown in Table 7.

Table 7. Most frequent relations between multiple coded instances of Q13 and Q23.

Q13 - How information from other departments is accessed	Q23 – Perceived level of intelligence culture	Number of occurrences
8	3	20
16	3	19
16	4	16
24	4	16
8	4	11

We can conclude that cases with on-demand information access from other departments, combined with self-service cases, dominate, indicating a strong role of user pull.

The responses to **question Q15 "How analytical insights inside organization are shared"** have been coded as follows: NK – no exchange of insights; KN – permanent exchange by direct communication; KB – insights are exchanged only during common meetings; NE – unaware. The instance count for Q15 is presented in Table 8.

Table 8. Instance count for responses to question Q15

Instance of a response	Count
KN – permanent exchange by direct communication	103
KB – insights are exchanged during common meetings	86
NK – no exchange of insights	9
NE – unaware	5
Other	4
Total:	**207**

The most frequent relations in the pair Q15-Q23 are presented in Figure 2, and the relevant frequency data are in Table 9.

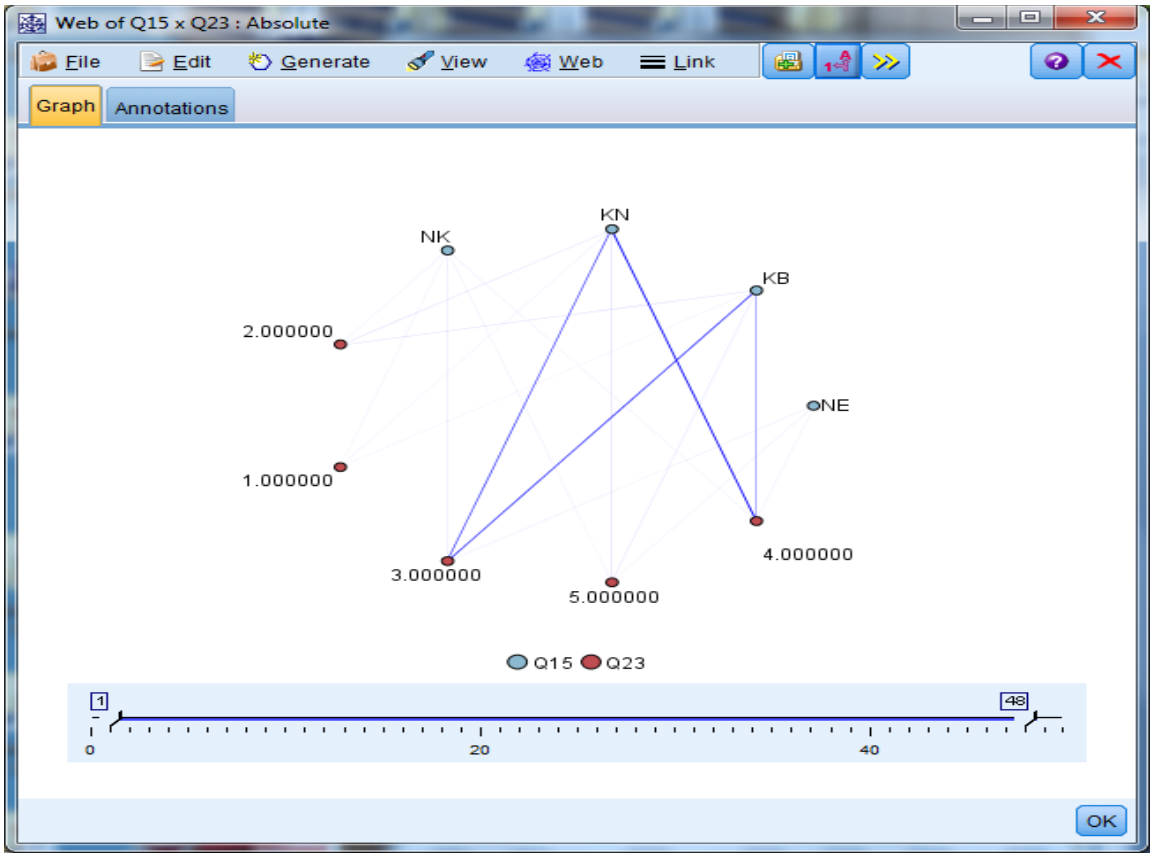

Figure 2. Relations between instances of Q15 and Q23.

Table 9. Most frequent relations between instances of Q15 and Q23

Q15 - How analytical insights inside organization are shared	Q23 - Perceived level of intelligence culture	Number of occurrences
KN	4	47
KB	3	40
KN	3	36
KB	4	29

The data shows that the most common occurrences involve responses KN – "permanent exchange by direct communication", and KB – "insights are exchanged only during common meetings", again pointing to the conclusion that, for higher levels of perceived BI culture, active information sharing between participants of BI activities is rather widespread, and sharing is performed both on formal and informal basis.

CONCLUSIONS

As shown by the results of analysis of survey data, the dominating share of respondents are well aware of BI culture, and the majority had perceived their business intelligence culture as being mediocre to excellent. Respondents who are the most satisfied with their business intelligence culture seem to possess an environment where information sharing is a natural way of executing business intelligence, and one of the key features of intelligence environment. By mobilizing human factors, business intelligence culture may serve as an axis of co-operative analytical environment that supports organization-wide information integration and standards for reliable evaluation of business environment.

Regarding information sharing, we can conclude that cases with on-demand information access from other departments dominate, indicating a strong role of user pull. For higher levels of perceived BI culture, active information sharing between participants of BI activities is rather widespread, and sharing is performed both on formal and informal basis. For higher levels of perceived BI culture, information sharing between participants of BI activities is a common and valued process. The analyzed factors have best predicted the levels of BI culture for instances 3 (mediocre) and 4 (good). For these levels, active information sharing and user pull are the most expressed.

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