**The Tunnel of Doctus KBS**

**The Deeper You Get the Darker It Is**

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**Abstract**

*When you are on your way inwards to a tunnel, it is getting darker and darker. You reach the darkest point when you are in the deepest. Then, as you start your way out, there is gradually more and more light. Over the last quarter century we were getting deeper and deeper in. It seems that it is starting to get lighter now.*

*As academics and consultants we have been working for, with and on top-level business decision takers involved in loosely structured decision problems. Gradually we have achieved better and better understanding of the models of thinking that can be useful for these decision takers. First we realized that the model of thinking needs to be simple; which is the philosophical commonplace of Occam's razor. Somewhat later we realized that it is easy to cut our-selves if Occam's razor is too sharp – the model of thinking must not be too simple as it will fail to provide a usable representation of reality. This is also known from philosophy as Einstein's extension of Occam's rule: as simple as possible but not simpler than that. Along these lines we have developed the Doctus knowledge-based system shell, for building our models. This way we started building the bridge of trans-disciplinarity between the knowledge do-mains of various experts. However, this bridge is narrow and difficult to use for crossing the disciplinary divides. Decision takers cannot walk the bridge alone; they need a bridge-guide called the knowledge engineer. The knowledge engineer is not a polymath (expert in multiple domains); the knowledge engineer's expertise is about knowledge and knowers.*

*More recently we have realized that it is not sufficient if the model is useful, it also has to be usable. The bridge should be wide, stable and easy to walk. Of course, it is still nice to have the knowledge engineer to guide the decision taker – it provides a fuller experience. What makes for such bridge? Today we think that we need to apply Occam's razor tempered by Einstein on the user interface the same way as we have previously used it for representing knowledge. The new Doctus is beautiful and as simpler as it can be – but not simpler than that.*

**Keywords**: *New paradigm of decision making, quasi-validation, relevant patterns of experience*

Track: *Management*

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## A Brief History of "How to Make Decisions"

In order to write on the history of something, we need to distance ourselves from the reality – and accept that we have to do so – as the reality cannot be 'written up'. We can write about a few particular events. This is what HBR undertook in 2006 (http://hbr.org/2006/01/a-brief-history-of-decision-making) about decision making. They remind us of many interesting events. We highlight one of them: Frank Knight (1921) was the first to distinguish risk from uncertainty. This is still perhaps the most difficult exam question on a post-experiential course on decision making. The source of the problem is that the common-sense use of the term of 'risk'. Common-sense cannot move away from Gauss' bell-shaped curve as the basis of the notion of risk, as if the concept of 'chaos' (Gleick, 1988) was still unknown. Thus Taleb's (2008) Black Swan has become the hot potato of decision research: it feels wrong both trying to hold it as well as throwing it away. This is just an illustration of series of events as they can be written about. What is important is that the selected events got included in the textbooks on decision making.

In 2013 HBR has taken on decisions once again (http://hbr.org/2013/11/deciding-how-to-decide/ar/1). According to the November 2013 issue of the Harvard Business Review, perhaps the most respected business magazine, labelled 'How to Make Smarter Decisions', the time of smart decision making has come. However, the decision making process will not become smarter if we analyse more and more data. Excellent CEOs know that it takes more than analytics. (Charan and Merino, 2013) Smartly prepared business decisions are born on the basis of 'knowing'. Cunliffe and Coupland (2012), for instance, argue that we create sense "if we can find justifications (narrative rationality) for our and others' actions." Leaders 'shape systems of meaning' to justify 'privileges and rewards' and then show what this shaping looks like. Today's decision makers are no longer struggling with lack of data. They are, however, more and more often struggling with handling the 'soft' aspects in their decision making process. This is what we offer to support with the Doctus KBS. It helps making smarter decisions for those who want to combine hard data and soft knowledge, who want to shape systems of meaning and make the inference process more transparent. If one uses the right tool(s), the odds of making a good decision go way up.

Perhaps it is worth examining what the academic journals are publishing about. Here we are taking a closer look at the IS/ICT-oriented journals providing an illustrative selection:

- From *Expert Systems with Applications*
  "Data Mining Techniques and Applications: A Decade Review from 2000 to 2011"

- From *Decision Support Systems*
  "Cloud Computing: The Business Perspective"

- From *Information & Management*
  Business Intelligence Success: The Roles of BI Capabilities and Decision Environments

- From *International Journal of Information Management*
  To Be or Not to Be in Social Media: How Brand Loyalty is Affected by Social Media?

The messages of behavioural economics slowly but evidently appear in companies, thus the models of complex decision making tend to move towards the direction of supporting intuitive decision processes. It is worth following the topics published in the journal and the discussions taking place the conferences and fora of the Society for Judgment and Decision Making (http://www.sjdm.org/). The term "decision" had 443 results; "cognitive" produced

340 results and "intuitive" gave 178 results. Decision making researches are evidently moving towards a soft(er) direction.

Examining the website of top management thinkers (www.thinkers50.com) the following global trends can be outlined:

- In the field of strategic business decisions – better to say strategy – Henry Mintzberg is present on every list. He is a nightmare to the transmitters of knowledge. By the time somebody has managed to understand what Mintzberg says, he comes up with something new. Even consultants do not really like him regarding that he is a great thinker against all methods, and cannot be typified in any way (Mintzberg and Westley, 2001, Huy and Mintzberg, 2003).

- Herbert Simon (1996, 1997) was included in the list of Thinkers50 list in 2001 – only that one time, as he died later in the same year. This is due to the rules of the list but if it was simply on the basis of influence, we are sure that he would be there each and every time.

- James March, Simon's colleague is also worth mentioning, who, however, has never been included in the list – although we find this strange. Like his colleague, he is not a man of calculations, and tends to draw attention to essential things such as the identity of the decision maker (March, 1994, March et al., 1991).

- Malcolm Gladwell first appeared on the list in 2005, and in 2007 he reached as high as the second position. Many were shocked to see that March: a journalist on the list of the most influential thinkers, simply blogging (and writing books!) about the essential things of the world!  Many even refused to accept his conception that decisions made in the blink of an eye are decisions at all (Gladwell, 2005). He was regarded as a journalist, and business schools tended to keep a distance from him.

- Daniel Kahneman (2011) describes two different ways the brain forms thoughts: System 1: Fast, automatic, frequent, emotional, stereotypic, subconscious and System 2: Slow, effortful, infrequent, logical, calculating, conscious. Kahneman covers a number of experiments which try to shed light on the differences between these two thought processes, and how they arrive at different results even given the same inputs. Terms and concepts include coherence, attention, laziness, association, jumping to conclusions, and how one forms judgements.

- The future of the upcoming decision researcher is also worth thinking about.  Sheena Iyengar is placed 48 on the list in 2011. She not only brought the genre of decisions back to the streamline, but thanks to her, the consolidation of a long-sought realistic attitude was also made available. In her book, she is searching for the answer to questions such as *"How free are we in our decisions?"*, or *"Can we let anyone make choices instead of us?" "By choice, we mean that we have an impact on ourselves and our surroundings.  In order to be able to make a choice, we should feel first that such impact (control) is possible"* she writes at the beginning of her book (Iyengar, 2011). She illustrates the differences between the two worlds of the second half of the 20th century by using thought-provoking examples through the glass of the freedom of choice, the desire for which is so inherent in people that even if we cannot say the word, we already make a choice.

# Our Brief History of "How to Make Better Decisions with Doctus"

As academics and consultants we have been working *for*, *with* and *on* top-level business decision takers involved in loosely structured decision problems. Gradually we have achieved better and better understanding of the models of thinking that can be useful for these decision takers. First we realized that the model of thinking needs to be simple; which is the philosophical commonplace of Occam's razor. Somewhat later we realized that it is easy to cut ourselves if Occam's razor is too sharp – the model of thinking must not be too simple as it will fail to provide a usable/useful representation of reality.

It all started in 1981 during Baracskai's doctoral research, when he got a research and development project about evaluating investment projects. At this time, he had an undergraduate degree in economics and was trained in hard OR, and his doctoral research focused on multi-dimensional Bayesian networks. The project included evaluating and analysing the financial feasibility of business loan applications. His recommendations supported the bank's decision making process whether or not to lend the money to the applicants.  This meant reading through hundreds of pages of a business plan and checking the financial and market indicators describing the business opportunity under consideration. Soon he realised that, hardly surprisingly, the various indicators were always set to show potential for success. Thus the question emerged: how to reveal the real strengths and weaknesses of the proposal? Baracskai decided to visit the companies seeking financial support from the bank and learn more about their circumstances. Through these visits he started to comprehend the importance of a knowledge which resists mathematical formalisation and requires a non-quantitative approach and thus cannot be captured by the financial and market indicators.  Furthermore such knowledge could fundamentally influence the 'big picture' formed about the company. This led to another question: how to capture this elusive 'soft' knowledge?  This triggered a search for an applicable tool, starting from areas he was familiar with, such as Game Theory, Bayesian Theorem and the various approaches of Multiple Criteria Decision Analysis. After several years spent searching, he realised that expert systems show a great potential in capturing this elusive knowledge.

In 1988, as a visiting professor at the University of Minnesota, Baracskai came across an expert system shell called GURU, which he purchased for $ 5,000. Inspired by this new conception, later that same year, at a postgraduate course on creative problem solving at the European Centre of Development and Peace in Sarajevo he drew up the following diagram:



**Figure 1**: The first draft

After the lecture two of the students invited him for lunch.  The students were Mija Bakalar and Dragan Šajić, the Director and a Software Developer of the Elektronski Računski Centar (Centre for Electronic Computation) of Šipad, a Bosnian forestry company. Shortly afterwards, they started to develop the predecessor of the Doctus KBS:  *"It is that simple: you*

*need someone who can provide the novum, someone who can appreciate the it and the restaurant Capri."*

Then the others came along. In 1990 Baracskai received a phone call from Marijan Šiljeg, the Director of the Elektronski Računski Centar (Centre for Electronic Computation) of Energoinvest, a Bosnian company engaged in the implementation and maintenance of power electronics devices. Šiljeg's group started automating (computerising) some processes of the company, such as documentation flow, bookkeeping, and inventory management. They carefully chose the aforementioned processes for the start as they argued that these processes are well-structured and they knew them well. The CEO of the company was impressed with their work, but he wondered then he asked: *"OK, but what's in it for me?"* Šiljeg realised that they are not able to capture the elusive knowledge inherent in CEO's work and he recalled that what Baracskai is doing could complement their work.

20+ years later, Doctus KBS is in its third version. It evolved rather naturally thorough applications with companies. Based on 1,000+ researches, consultancy and teaching applications the main lessons learned are the following:

- *the importance of being prepared*: it is not sufficient to learn some data from company reports, it is equally important to experience the human relations within the company;

- *the importance of small things*: revealing knowledge about seemingly unimportant things can build trust between the knowledge engineer and the company (experts and decision takers alike);

- *the importance of understanding the company/industry jargon*: if we do not speak the same language we cannot make sense of standard terms, such as risk, success or new products; and

- *the importance of capturing the local informal knowledge*: the acquisition of heuristic knowledge which is usually hidden, hence requires dealing with people beside the computers.


## In the Tunnel of IS/ICT-based Decision Support

During the last 40 years, the attitude of Decision Support System (DSS) developers was mainly dominated by 'push' marketing strategy. It was not the decision taker who requested solutions. It was the system developer (who was never an expert in Business decision making) who came up with a solution and the decision taker either accepted or refused the solution. We might as well say that any DSS had only as much mathematics at its basis as much as the IT developer knew.

Stephen Baker (2009) describes the Numerati struggling with the challenges of data overload – on which they apply statistical analyses that do not reach the limit of understanding of the average elementary school pupil. Ironically, the sheer amount of data to be processed poses a serious technical challenge, which results in laboratory full of scientists who sacrifice their weekends and order pizzas late in the night – in order to teach the machine what we humans know in a blink of an eye…

*"The problem managers face is not a lack of appropriate tools. A wide variety of tools— including case-based decision analysis, qualitative scenario analysis, and information markets – can be used for decisions made under high degrees of uncertainty. But the sheer*

*variety can be overwhelming without clear guidance about when to use one tool or combination of tools over another. Absent such guidance, decision makers will continue to rely solely on the tools they know best in an honest but misguided attempt to impose logic and structure on their make-or-break decisions."* (Courtney et al., 2013)

In the earliest days, the field was dominated by DSS models based on linear programming, in order to find optimal solution of (scarce) resource usage. The European Journal of Operational Research provided numerous models. Later in the 1970s, different variations of multi-criteria decision making methods were abundant, and it was that period when PROMETHEE Method for Multiple Criteria Decision-Making (Brans and Vincke, 1985) was dominant. In 1988, we encountered *GURU expert system development environment for the first time, which was developed by Micro Data Base Systems (Shafer and Anacker, 1986).*

*In the world of IS/ICT there was no paradigm shift, it is still dominated by the principle of the Turing-machine – i.e. information systems are still about performing machine commands. This does not mean, however, that there was stagnation in any sense – there was a plethora of changes, from which perhaps the most important (and less recognised in the area of decision support) is the use of the principles of aesthetics.*



**Figure 2:** A possible future of GUI

*Today it is not sufficient to be new – you also need to look new. There are still programmes running on DOS platforms – only the do not attract anyone. Spreadsheets also appear less and less attractive. When we initially dreamed up Doctus, we have foreseen that the spreadsheet-like appearance will be attractive. And it was for a while. This is why the appearance of Doctus reminds of a spreadsheet although it has nothing to do with simple calculations. Today we believe that Doctus needs a new appearance. (Baracskai et al., 2007)*

*According to Taleb "we must learn how to make our public and private lives (our political systems, our social policies, our finances, etc.) not merely less vulnerable to randomness and chaos, but actually 'antifragile' – poised to benefit or take advantage of stress, errors and change, the way, say, the mythological Hydra generated two new heads, each time one was cut off…"* This makes the Hydra a strange creature that benefits from hostility. Of course, only if we assume that cutting off someone's head to be hostile behaviour. In Extremistan, the successful is antifragile, that not only resists the unpredictable Black Swan but also benefits from it. In this vein, we believe that the tablet computer is not the enemy of Doctus – it is our chance to make Doctus platform independent – while at the same time we can throw away what is too fragile.

**Reaching the Darkest Point: Reusing Previous Decision Experience**

Contrary to the world of IS/ICT there was much less change in the world of decision making. And contrary to the world of IS/ICT we believe that the world of decision making a paradigm shift is imminent. The essence of this paradigm shift is that in the era of knowledge abundance the models based on the idea of scarcity of resources are losing relevance and are bound to play lesser and lesser role. Our research to date shows that in smart decisions the emphasis is on behavioural patterns, behind which we recognize patterns of cognition. With *experience mining* we attempt to tackle these patterns of cognition through exploring the relevant *rules of speculation*.

In 2011, the writer and blogger Nicolas Carr (2011) gave his book the title *"The Shallows: What the Internet Is Doing to Our Brains"*. He describes how the newest achievements of IS/ICT are distracting us and do not let us focus on one thing at a time and sustain concentration longer. The information overload is urging us to continually browse and 'quick-scan' contents.

The idea of validity is inherited from experimental sciences and is concerned with the question of where a particular knowledge applies – i.e. what is the domain of validity. It is closely linked with the notion of generalizability, which refer to extending some knowledge beyond the domain from which it has been obtained. Some of the underlying concepts of validity only apply in a positivistic approach, although some requirements also make sense in the non-positivistic world. One of these is internal consistency which we consider also a necessary condition in our view of quasi-validation. Where our conception of quasi-validation departs from all other approaches of validity is that it is only concerned with one single instance of application at a time and the validation process is an evaluation of the 'big picture', obtained through 'abductive' reasoning (with limited possibility of verbalization), in terms of the conditions of that single instance.

The third kind of reasoning, that we developed most recently, was born from the idea that if it was possible to find out the outcome based on attributes and rules, and it was possible to find the rules based on the attributes and the outcomes, it should also be possible to find the attributes based on the other two. Well, this is not entirely true, as it is impossible to define the rules and the outcomes without describing the attributes first. However, we can also observe that the case based graph, the graphical display of the inductive reasoning, normally does not contain all the attributes, only a few of them. So, although we cannot find the attributes based on the rules and the outcomes, we can find out which attributes are relevant in a particular decision. This is what we can read from the case-based graph – the informative attributes. Consequently, we developed a feature to convert the outcome of the inductive reasoning, i.e. the accepted case-based graph, into a deductive knowledge base by a click of the mouse. As the number of the attributes is thus reduced we call this third type of reasoning reduction or *reductive reasoning*.

It is important that, while we have fewer attributes in reductive knowledge base, it classifies all the cases in the same way as when we used all the attributes in inductive reasoning and what a complete deductive knowledge base featuring all the attributes would provide. It can be said therefore that the reductive knowledge base is denser than a corresponding deductive one. It is possible that there will be no complete rule sets in some of the nodes of the new single-level rule based graph but these will usually indicate impossible case situation or, at any rate, a sort of a case that the experts have not seen before.

There is an interesting way to make an existing deductive knowledge base denser: first we build a deductive knowledge base, define the full rule set, describe all the cases and apply the deductive reasoning to obtain the evaluation for all the cases. When we have the outcomes, we run the inductive reasoning on the same knowledge base (excluding the dependent attributes) and thus we obtain the case-based graph which describes all the cases using only the informative attributes. Finally we extract the rules from the case-based graph by applying the reductive reasoning. The reductive knowledge base will give the same output value for all the cases as the deductive knowledge base we started with, only using fewer (often significantly fewer) attributes.

The above description implies that in the most recent incarnation of Doctus we are able to *identify relevant patterns* from previous decision situations by other decision makers, learning from which can be helpful to the decision makers with the decision situation at hand. Thus reductive reasoning supports *reusing previous decision experience*. As it often happens connecting a few existing technical solutions and adding a really simple new feature results in a solution which has the potential of completely redefining the user experience – in this case the experience of the decision takers. As far as we know, Doctus is currently the only decision support tool capable of identifying *relevant experience* as well as learning from it.

The thinking behind the idea of reductive reasoning follows the logic describe by Handy (2008) according to which the trick is not to try to fit the whole thing into our minds but to know where the find what is relevant, how to approach it and what to do with it once we find it. It is not simply a knowing process but a more complete cognitive process (Dörfler and Szendrey, 2008) or as Taleb (2008) says, although men's tendency for certainty is natural, it is still more about an intellectual passion.

Of course, using or, more precisely, reusing previous experience also requires high level of expertise. As in any benchmarking the ultimate rule of the lead practice applies: 'Don't Copy!' In other words, we need to understand the model of thinking before attempting (re)using it – making necessary adjustments first.

> *"You are wrong if you praise things you don't really understand – but you are even more wrong if you condemn them."* (Leonardo da Vinci)

Let us take a typical "if… then" rule set describing experience. In Doctus rules are listed in processing order, i.e. the inference engine is starting from the top of the list searching for a rule that applies and stops searching once the first applicable rule is found. This means that if a combination of factor values has multiple coverage, the top outcome will apply and the 'hidden' ones will have no effect on the result. The process works as follows with a simple example for illustration (Figures 3&4):

The topmost rule is checked first, whether it matches the case features for the all factor attributes. If yes, the adequate rule is found, otherwise the search is continued at the next rule. The first rule of says: If 'Reference' is 'excellent' and 'Finance' is at least 'good', then 'Tender' is 'excellent'. If not, the second rule is examined. Both factors, i.e. 'Reference' and 'Finance' have five values, they are marked by 'marbles' at the bottom layer of Figure 3. The marble at far back represents 'excellent' 'Reference', while the one at near in front is for 'excellent' 'Finance'. The purple piece of surface on the top represents the first rule. The blue one is the last rule covering the whole domain. So the 'excellent'-'excellent' combination is covered five times. Considering the processing order, an upper rule hides the other ones below it. If no matching rule is found, i.e. the combination of factor values belongs to an

uncovered domain, the rule outcome in the node will be 'unknown'. The situation will be the same if the case feature for one factor is 'unknown' (i.e. one of the rule inputs is 'unknown').
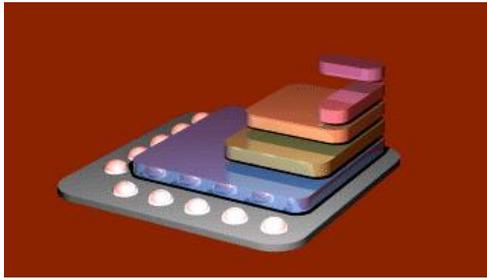


**Figure 3:** Rules by levels

The surfaces on Figure 3 represent complex rules as each of them covers more than a single combination of factor values. The complex rules can be broken into elementary rules (Figure 4) and then it is possible to delete all the hidden rules, achieving a single-level coverage and then new (simpler) complex rules can be defined by assembling the neighbouring elementary rules; this way we can achieve the lowest number of rules that provide a full coverage in a particular node. However, often the layered rules from Figure 3 can be more beneficial, e.g. as it represents a thinking process along the lines of "if XY is xy then the outcome is at least Z". Thus we have achieved a full circle getting back to the layers from Figure 3. However, if there was a lot of hesitation or a number of changes when the experts verbalized the rules, it is possible that there is also significant redundancy in the rule set and possibly a number of rules that can never be used as they have no visible parts looking at the node range from above. In order to get from such a messy high-redundancy situation to a clean situation on Figure 3, we connected all the previous steps into a single one that we named 'purifying the rule set'.



**Figure 4:** Broken up complex rules

The reductive knowledge base in Doctus provides a representation of the patterns of relevant previous decision experience which we offer for reuse to the shallows-era decision makers. In other words, we teach experience mining to Doctus 4.0.

It is essential that the decision support solution 'shell' running on a tablet computer is attractive simply because of its beauty and simplicity. Now we can see that we have included in our shell more than a few things that are superfluous to the practicing decision maker. In the current development cycle we try to provide the simplest possible user experience. This does not mean that the role of the knowledge engineer will disappear. This is probably the most important in the case of reductive reasoning – when the abyss between the decision situation at hand previous and the decision experience that we want to reuse needs to be bridged. This bridge is narrow and difficult to use. Decision makers cannot walk the bridge alone; they need a bridge-guide – the knowledge engineer. The knowledge engineer is not a

polymath (expert in multiple domains); the knowledge engineer's expertise is about knowledge and knowers.

## Instead of Conclusion

Our current undertaking is that we are trying to convince the field and the domain about what we believe in. This is a tricky mission as our beliefs are ill-structured and we are expected to provide the view of a well-structured future – and part of our ill-structured belief system says that the future cannot be well-structured at all. We want to support decision makers who live in an ill-structured turbulent world where only the minority of decision aspects allows for calculations and these typically tend to be the less important ones.

Morse (2006) uses the example of Jean-Paul Sartre as a known womanizer who derived more pleasure from seducing women than from physical part of his affairs. This is the illustration of the difference between the passion of the hunter and the celebration of the trophy.

Perhaps we also find it more important or exciting to seduce the picky decision maker than to enjoy the profits from the sales. We have put together the canvas below (Figure 5) and it helped us understand a few important steps for the future – which does not mean that we will follow them.

| KEY PARTNERS | KEY ACTIVITIES | VALUE PROPOSITIONS | CUSTOMER RELATIONSHIPS | CUSTOMER SEGMENTS |
|---|---|---|---|---|
| • advisors (lawyer, IP, startup)<br>• universities<br>• clusters, chambers of industry and commerce, umbrella organizations<br>• **brand ambassadors**<br>• **opinion leaders**<br>• subcontractors: animators, graphic designer, movie makers<br>• special translators | • knowledgebases<br>• development (app & cloud)<br>• **website**<br>• video & animation<br>• startup and B2B events<br>• PR management<br>• customer support<br><br>**KEY RESOURCES**<br><br>• angels & investors<br>• early adopters (university, startup circles. Spin-off)<br>• demo users | • Decision making process will be shorter/faster<br>• Multi-participant (-practitioner) decisions will be transparent<br>• Decision makers will save consultant costs<br>• Managers will get the leading practises of relevant business decisions<br>• Companies will build own knowledgebases (with masters's level of knowledge) | • promotion (best KB, most active user)<br>• premium support & consultation<br>• symbiosis (VIP users)<br>• extra course for VIPs<br>• extra KB for VIPs<br><br>CHANNELS<br><br>• website<br>• app stores<br>• direct sales<br>• consultant companies<br>• umbrella organizations | • Head of small businesses<br>• CEOs, CKOs, CHOs, CMOs, CLOs of middle to large companies<br>• Consultants (management and/or IT: middle sized consulting firms)<br>• Serial project companies<br>• Decision makers in public service |
| **COST STRUCTURE** | | | **REVENUE STREAMS** | |
| • development staff & management<br>• hosting & security<br>• marketing & PR<br>• advisors | | | • licence<br>• knowledge bases<br>• consultation<br>• BI integration Big Data opportunities | |

**Figure 5:** Canvas

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