On the other Side of Technology: Examining of Different Behavior Patterns with Artificial Intelligence

Bernadett Domokos, Zoltán Baracskai

Doctoral School of Regional Sciences and Business Administration, Széchenyi István University, Egyetem tér 1, H-9026 Győr, Hungary
domokos.bernadett@sze.hu, baracskai.zoltan@sze.hu

Abstract: In this study, the initial problem is the capacity of the human mind to set up a conceptual model. The novelty of this article is that we show that defined concepts created by the human mind can be passed on to an artificial intelligence-based expert system. The expert system helps the human mind to settle the logical connections between the defined terms and the conceptual model thus the created model will be better than what man could have set up without an expert system. The appearance and role of employee turnover has become a more and more important factor in the daily business of corporate life. Scientific journals have examined the positive and negative effects of it, which has also provided useful knowledge for practitioners. These articles have examined the impact of employee turnover in countless aspects, but one aspect was the same in all literature: the impact of turnover on a company is not negligible and cannot be ignored in terms of neither material nor moral aspects. As a starting point for our research, we systematically reviewed the literature on employee turnover and selected six concepts that are bilaterally related to our phenomenon. Based on the terms and the correlation of it, we created a conceptual model that was examined with the help of an artificial intelligence-based system. To select a system, we reviewed the classifications of the artificial intelligence-based systems which can model human decision making and can help our research. Relying on the processing of the literature review articles, we selected and briefly characterized a rule-based reasoning system, and investigated the rule constellations of it, which can model the turnover cases as the topic of our study. Based on our experience in observing, consulting, and working with decision-makers, we examined the aspects of employee turnover phenomenon in the analysis and we constructed a three-level model that found logical relationships between each subcategory and was able to realistically reflect certain behavioral patterns of the physical workforce of a manufacturing company. The analysis was performed using a rule-based system, which used logical rules and found classical "if-then" connections in the employee behavior cases. According to our examination, our outcomes can provide credible results for further research activities as well as for practitioners.

Keywords: manual worker; rule-based reasoning; employee turnover

1 Introduction

In our competitive business world, different approaches and trends have been taking the importance and role of human resources into account more and more. The importance of knowledge and knowledge sharing of human workforces have become increasingly important over time. This is the reason why the retention of professional workers remained an increasing effort for the companies and this trend has also appeared in the increased number of articles about the phenomenon and impact of employee turnover.

„Turnover is costly because it incurs recruitment costs, training costs, and separation costs. Besides that, turnover also incurs indirect costs such as loss of productivity, reduced morale of the remaining employees, loss of quality, loss of clients, and additional work for the remaining employees. That is why organizations should strive to reduce turnover if possible" [1] and need to control it with several tools.

Numerous aspects and effects of employee turnover appear in each literature. Different approaches call attention to different centers and different levels of the topic. Most of the literature examines the individual aspects of employee turnover and not only treats the turnover itself as a possible output, but also distinguishes between turnover intention and turnover itself. All possible final form of employee turnover as employee behavior is mentioned under the name of withdrawal behaviors. According to the articles, the following "three key indicators from among the wide array of potential withdrawal symptoms: lateness, absence, and intent to leave work" [2] are identified.

On an individual/personal level, a significant portion of the literature examined deals with employee satisfaction and its positive - negative impact on the organization. "Job satisfaction is among the most frequently assessed work outcomes of fit, not only due to its own importance, but also because job satisfaction can play a key role in linking fit with other outcomes" [3]. Satisfaction is the marketing and trade-oriented literature that was identified as "the end state of a cognitive process during which consumers compare their expectations with the subjectively perceived value, they receive from their consumption" [4].

Another part of the articles deals with employee commitment and emphasizes the positive impact of it on corporate performance. "Commitment to key customers, can be sources of competitive advantages that improve performance" [5]. "In the United States, adoption of commitment practices accelerated in the 1990s and has largely been found effective in boosting firms' financial performance as well as employees' motivation" [6].

Individual performance and its impact and results as one other potential approach is also examined in the studies from different aspects. "Employee turnover negatively affects performance, and indeed, higher turnover rates are associated with lower levels of productivity [7], customer service [8], and profits [9]" [10], therefore, the investigation of it can be important.

When we examine the conceptual relationships at an organizational level in terms of employee turnover in the published literature as well, we can find numerous studies on organizational trust. According to the articles, trust is defined as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" [11] and symbolizes the non-measurable performance of the companies. Several studies and analysis deal with the problem field of corporate trust and investigate its impact on daily business [12] [13] [14] [15].

A significant portion of employee turnover studies of the organizational level found the answer for the phenomenon in the existence or non-existence of organizational well-being [16] [17] [18] [19] and several published articles examined the concept of organizational respect [20] [21] [22]. These professional studies also research and analyze the impact of organizational respect on the organization as a whole structure.

2 Role and Classification of Artificial Intelligence

2.1 Terminus Technicus and Metaphors

"The human brain is by far the most complex physical object known to us in the entire cosmos" states Owen Gingerich, an emeritus professor of astronomy at Harvard University. This short quote is a good symbol of the complexity and inexhaustibility of human thinking.

The unrecognizable maze of human behavior is an untapped resource for science. We make a myriad of decisions during the day or in our lives that can significantly affect our future. According to behavioral economics, there are not only „econs" [23] in the world who rationally consider possible outcomes before each of their decisions. Behind every decision, there are thoughts, experiences, and associations, which people have lived and have collected intuitions about everything that they sense. Therefore, these turn into knowledge all of which can help them make decisions later. „Fast thinking includes both variants of intuitive thought – the expert and the heuristic – as well as, the entirely automatic mental activities of perception and memory, the operations that enable you to know there is a lamp on your desk or retrieve the name of the capital of Russia" [24].

Working of the human brain serves as a source for the research area of Cognitive Infocommunication as well. This research area examines human behaviors and the working of the human brain from an “engineering” viewpoint. Most of all they use technological tools in their analysis. “CogInfoCom is to provide a systematic view of how cognitive processes can co-evolve with infocommunications devices so that the capabilities of the human brain may not only be extended through these devices, irrespective of geographical distance, but may also interact with the capabilities of any artificially cognitive system. This merging and extension of cognitive capabilities is targeted towards engineering applications in which artificial and/or natural cognitive systems are enabled to work together more effectively” [25].

Numerous researchers have tried and are still trying to map the functioning of our brain and the logic behind our decisions from different points of view. “Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature” states George Lakoff, a cognitive linguist and philosopher from the University of California, who introduced the conceptual metaphor theory in several parts of the scientific world also in mathematics. He led his study of the functioning of the human brain back to metaphors and found that “conceptual metaphor is a natural part of human thought. We don’t have a choice as to whether to think metaphorically. Metaphorical maps are part of our brains because we will think and speak metaphorically whether we want to or not…..our brains are embodied, our metaphors will reflect our commonplace experiences in the world. Inevitably, many primary metaphors are universal because everybody has basically the same kinds of bodies and brains and lives in basically the same kind of environments, so far as the features relevant to metaphor are concerned” [26].

However, more systems have emerged in order to assist people in making certain decisions over time, these systems could not perfectly model reality and the diversification of human behavior patterns. “A lot of remarkably insightful mathematicians, logicians, linguists, psychologists, and computer scientists have designed objectivist models for use in the human *sci*ences. Are we claiming that all of this work is worthless and that objectivist models have no place at all in the human sciences? We are claiming no such thing. We believe that objectivist models as mathematical entities do not necessarily have to be tied to objectivist philosophy. One can believe that objectivist models can have a function—even an important function—in the human sciences without adopting the objectivist premise that there is an objectivist model that completely and accurately fits the world as it really is” [26]. Baracskai et al. (2017) wrote in an article, that “smartly prepared business decisions are born on the basis of “knowing” [27]. Basically, these systems use human knowledge and experience to create quick and effective decisions, but the AI algorithm always behaves as an “econ”. In 1989 Adelman was the first researcher, who dealt with the phenomenon of knowledge and identified five determinants of knowledge base quality as domain experts, knowledge engineers, knowledge representation schemas, knowledge acquisition techniques and problem domains [28].

2.2 Expert Systems

The expert systems are one of the most supportive systems in the human decision making process of the business world. These systems are able to transfer the human knowledge to a computer logic, which can simplify and model the reality in an AI environment, and through this mechanism, these computer-based solutions can serve as a good basis to find specific advice for business, organizational, engineering, etc. problem if it is needed [29]. Therefore, these systems can be applied to several parts of the daily work and business. In the developing world, artificial intelligence is gaining ground, and its field of application can be quite diverse.

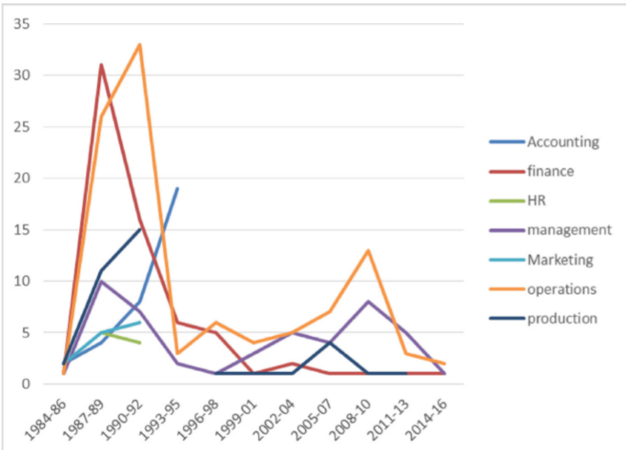


Figure 1
Expert system applications by the functional area over time

Source: W. P. Wagner, 2017

W. P. Wagner (2017) analyzed the dimension of expert systems in his comprehensive analysis from 1984 to 2016. In this study, 311 expert system case studies are identified painstakingly and these are defined as the areas of application that have made the most intensive use of artificial intelligence in this direction over the past three decades. He found that most of the industries, manufacturing, and banking, accounting services enjoy the potential of these systems. Besides the industries of application, he identified the potential problem domain of the system. The diagnosis, monitoring and planning are that areas, where the use of artificial intelligence-based systems is most prevalent [30].

Shain et al. (2012) analyzed the hybrid expert systems approaches and their applications. Their examination is based on the classification of 91 published articles from the related academic journals, conference proceedings and literature reviews between 1988 and 2010. These systems use a combination of conventional symbolic rules and hybrid models as a solution in analyzing proposals to solve problems that arise [31] [32]. The paper categorized the different hybrid expert system papers “according to system structures such as neural network based expert systems, neuro-fuzzy expert systems and rough neural expert systems and several other criteria such as algorithms, application categories and building/implementation tools” [31].

We consider the categories-classification by Liao (2005) as knowledge background for the theoretical basis of our study. He surveyed "the development of expert systems through a literature review and classification of articles from 1995 to 2004 as a basis exploring the expert system methodologies and applications during that period" [29]. According to the screening of 166 articles from 78 academic journals, he identified eleven categories as classification However, out of these classifications, we focused on and investigated the rule-based systems, knowledge-based systems and the case-based systems as areas of interest for our examination and we examined the operation of these systems more thoroughly.

The rule-based systems as the first category of the classification [33] [34] [35] [36] [37] [38] deals with information from human observations and transforms it into classical rules. “Logical Elements Rule Method for assessing and formalizing clinical rules” [39]. The typical basis of these systems is the "if-then" rule in the different decision making processes. According to the orientation of our topic, we have reviewed the literature and case studies regarding the applicability of the rule-based system that can primarily help in modeling the day-to-day problems of production companies. From the numerous fields of application of the system, we focused first of all on production planning, knowledge acquisition, material processing, automobile process planning oriented articles.

The knowledge-based decision support systems are systems that support decision-makers. The increasing use of AI-enabled systems in the late 1990s not only to fulfill this supporting function but also to provide an opportunity to map causes and relationships. Zaraté and Liu (2015) studied more than 70 journal papers and defined the most used technologies of knowledge modeling and technologies for reasoning [40]. According to the study, it distinguished two technologies for knowledge modeling as: clustering and ontology, and five technologies for reasoning as: rule-based reasoning, case-based reasoning, narrative-based reasoning, ontology-based reasoning and genetic algorithm as another classification of expert systems [41] [42] [43] [44].

“The basic idea of case-based reasoning is to adapt solutions that were used to solve previous problems and use them to solve new problems. In case-based reasoning, descriptions of past experience of human specialists, represented as cases, are stored in a database for later retrieval when the user encounters a new case with similar parameters” [29]. “It is king of implementation of a sort of automatic ranking of past lessons and making available best practice cases”.

Therefore, this system works with cases from the past and the information about these cases can help for the diagnosis creation for the new ones, and it is able to make inference for the future, so the basis of practical advice comes from the past experience [44], [45].

3 Conceptual Framework and our Examination Method

In our research work, we examined the approaches and circumstances of the phenomenon which occur most typically in the context of employee turnover within the framework of a comprehensive literature review. Based on our systematic analysis, we have separated two levels of the phenomenon: the organizational level and personal or employee level. At these levels, we further examined the conceptual circles that can be logically related to the initial set of problems.

From the two examined categories, we furthermore identified three-three additional attributes (variables) that clarify and identify our used phenomenon on the second level and it characterizes them sufficiently for our research. At the personal / employee level, these attributes are measurable performance, satisfaction and commitment. Based on our model, we defined three values for the attributes that can be further chiseled in the future to increase the sensitivity of the research model. At an organizational level, we also identified three attributes: trust or non-measurable performance, respect, and organizational well-being, which have every three outputs.

Based on these, we identified two triads which also appear as two different organizational levels in the corporate environment.

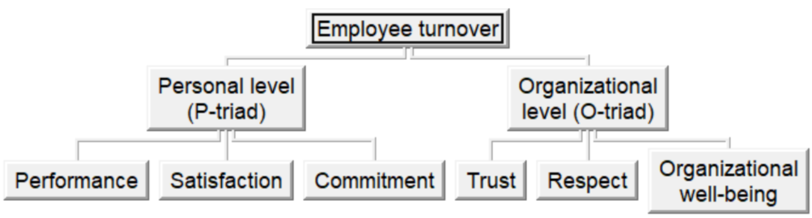


Figure 2
Graph of our conceptual model on the basis of the literature review

According to our model, the logical relationships between the two triads serve to represent one of the values of turnover, which can be inferred from the appearance of the sub-values. The possible outcomes of employee turnover were also described by three values, which were named as often, occasionally and in the last case.

We tested our conceptual model with some well-distinguishable cases, which are based on our research in contexts of employee turnover. We were typically interested in the logical if-then rules, therefore, we chose this examination category from the above-mentioned classification. The used part of the Doctus help us examine it in more depth. This system explores practical problems through rule-based reasoning and case-based reasoning technologies and models possible triggers and weaknesses. We used only the rule-based reasoning side of the system to model our examples.

This part of the program operates as a typically rule-based expert system and uses "symbolic representation, that is to say symbolic artificial intelligence" [45]. According to the system documentation, these "formalism in which knowledge is expressed by logical statements consisting of symbols, namely self-defined terms of the expert (i.e. words) connected by "if… then" rules, also called production rules. Therefore, Doctus belongs to domain of Symbolic Artificial Intelligence" [46]. This system works on different cases which are defined as decision alternatives, which can be useful for an organization in the decision making process.

"The evaluation of cases is called reasoning. There are three types of reasoning in Doctus. If the expert can articulate the important aspects of the decision as well as the rules, the system will trigger these rules to get the evaluation. This is called deduction or Rule-Based Reasoning. It is used when there is no experience in the domain, therefore, the situation calls for Original Decision (G-2)" [46].

In our research, we primarily investigated the consistency of the selected if-then rules. As a result, four different termination situations served as test cases yielded three different values for employee turnover, i.e., the cases used authentically supported and modeled the reality. From this, we concluded that both the attributes and the values, as well as the defined rules between them, were parameterized well according to the purpose of the research.

4 Illustration

Our used artificial intelligence-based system works with different attributes along with rules. In the course of our research, we created the rules with the help of an expert that allows the system to evaluate behavioral patterns. Therefore, we have provided some attributes of our conceptual model with values that don't come from engineering terminology, not the results of specific measurements, but metaphors which are able to describe and characterize certain moments of human behavior within our concepts, which are based on our reorganized literature review. In our research, we have recognized, that although the appearance of our used terminology is the same in the daily language, in the consulting practice, and in the human resource jargon, but their meanings have some differences, therefore, based on sense-making we made new sense. In determining the values that can be included in each concept, we sought to ensure the widest possible range of values. As a result, three values were determined, and the values of each attribute go far from the most unfavorable output to the most favorable. Regarding the number of values, we considered the three and four values to be ideal for tracking the operation of the system and the mapping of the rules. In the present case, three values were used to test the operation of the system.

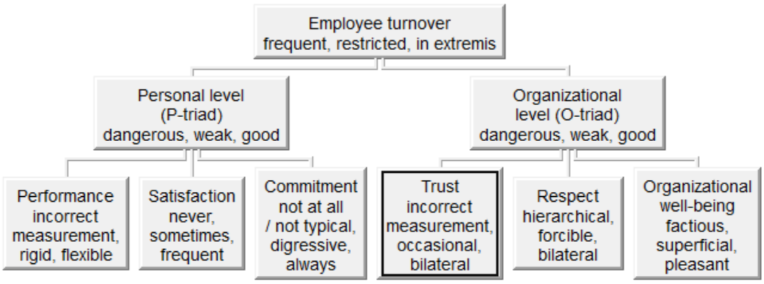
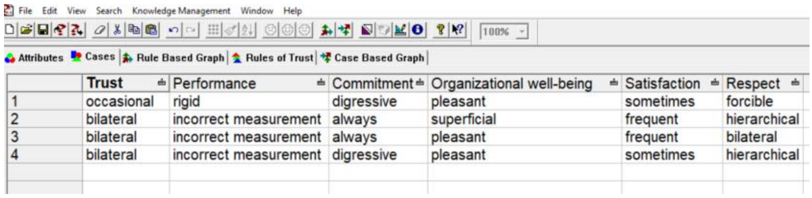


Figure 3
Our conceptual model with values

As can be seen from Figure 3, our predefined values to each concept's elements are not collected from a lexicon, but they well characterize the peculiarities of human behavior. For us, artificial intelligence is an integral part of our further work and we have called it to help in the creation of a more exact, clearer, faster and more valuable solution for the functioning of the human brain. With the help of applied information, the system is able to create and state complex rules in an incomprehensibly short period of time, what the human brain is unable to accomplish. The machine is fast, it doesn't forget anything and capable of handling dozens of data simultaneously. These are the endowments that appear as weaknesses when examining the functioning of the human brain.

At the creating of the conceptual framework, we built our model into three levels in order to form a transparent set of rules that can provide manageable and transparent information in each decision-making process. Therefore, under the main term (employee turnover), two main groups have been implanted, which further systematize the individual attributes. If the second level had not been included in the structure of the model, all six attributes what we could relate to employee turnover from the literature review, would have been directly related to the main category, so six times we would have had to create three values in this case that would have resulted in opacity.

As the next step in our work, we identified four typical employee turnover cases with the help of the expert that arose as a result of personal consultation with physical workers at a manufacturing company. It was necessary to know the cases, in order to create the rules as precisely as possible. We have placed great emphasis on case processing to demonstrate the proper functioning of the system and to ensure the most valuable benefit of the system, that information technology helps human thinking in which the human brain is not "strong" enough. It helps us to perform a quick and complex analysis of the combination of concepts and phenomenon from the literature review and cases from practice.



	Trust	Performance	Commitment	Organizational well-being	Satisfaction	Respect
1	occasional	rigid	digressive	pleasant	sometimes	forcible
2	bilateral	incorrect measurement	always	superficial	frequent	hierarchical
3	bilateral	incorrect measurement	always	pleasant	frequent	bilateral
4	bilateral	incorrect measurement	digressive	pleasant	sometimes	hierarchical

Figure 4
Cases with the possible answers

Based on the uploaded data, our model looks like Figure 4. The values can be found under the concepts by each attribute. The information was provided by the employees who left the production company or organizational unit and their restrictive answers were channeled to each value after the discussion with the expert.

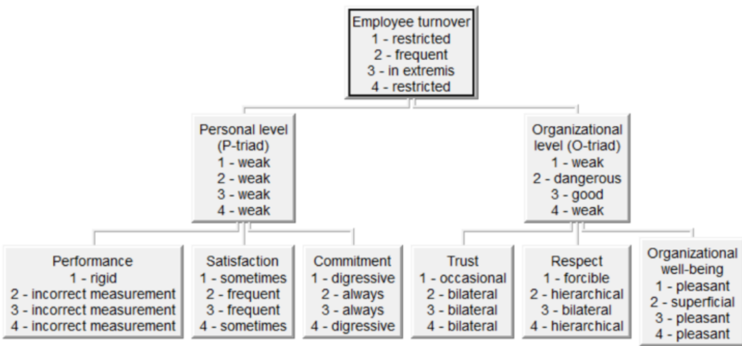


Figure 5
Conceptual model with cases and values

As we can see in the first case, the trust of the manual worker in the company was “occasional”. According to the interview, it was influenced by the current company news, information and circumstances. The performance he assessed was less aligned with personal performance indicators, and was assessed solely on the basis of his measurable performance, therefore, the performance value is “rigid” here. His personal commitment is “digressive”, and its well-being is “pleasant” in the organization. In terms of satisfaction, it was only “sometimes” said to be so, and according to its assessment, the respect experienced in the organization was “forcible”. Based on the table of given answers, each case can be reviewed in detail in a similar way to the first. In case the system cannot interpret or work with a particular rule, a new rule must be defined for it. The graph of the model with values makes the result of our conceptual model transparent to us.

With the help of the intelligent information technology system, we have the opportunity to examine and if it is necessary to review those inferences, which were generated as conclusions by our rule-based system from the coded answers of the expert. The complex rules created by the intelligent system are shown in Figure 6 and Figure 7 for both personal-level rules and organizational-level rules.

File Edit View Search Knowledge Management Window Help

Attributes | Cases | Rule Based Graph | Rules of Personal level (... | Case Based Graph

Performance	Satisfaction	Commitment	Personal level (P-triad)
incorrect measurement	*	not at all / not typical	dangerous
*	never	.. digressive	dangerous
incorrect measurement	never	*	dangerous
rigid ..	never	always	weak
incorrect measurement	sometimes ..	digressive ..	weak
rigid ..	sometimes ..	not at all / not typical	weak
.. rigid	sometimes	digressive ..	weak
flexible	sometimes ..	digressive ..	good
rigid ..	frequent	digressive ..	good

Figure 6
Rules of personal level

It can be clearly seen from the two figures that the system processed answers that presumably processed reasonable, rational, consistent thoughts and answers, as we did not receive any negative feedback from the system and the attributes use all values in the model.

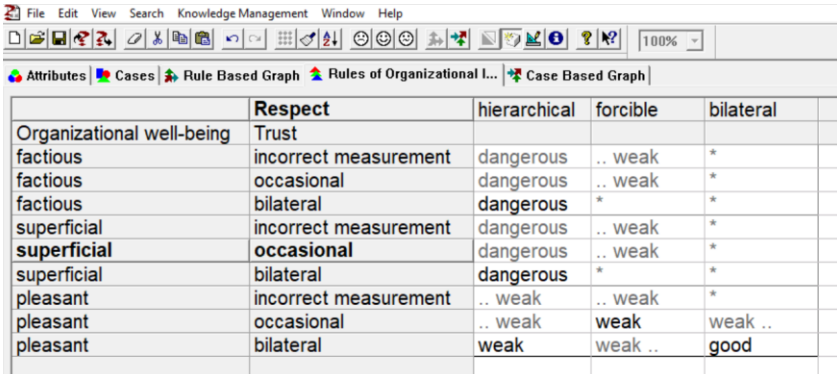
File Edit View Search Knowledge Management Window Help

Attributes | Cases | Rule Based Graph | Rules of Organizational l... | Case Based Graph

	Respect	hierarchical	forcible	bilateral
Organizational well-being	Trust			
factious	incorrect measurement	dangerous	.. weak	*
factious	occasional	dangerous	.. weak	*
factious	**bilateral**	weak	weak ..	weak ..
superficial	incorrect measurement	dangerous	.. weak	*
superficial	occasional	dangerous	.. weak	*
superficial	bilateral	dangerous	weak ..	weak ..
pleasant	incorrect measurement	.. weak	.. weak	*
pleasant	occasional	.. weak	weak	weak ..
pleasant	bilateral	weak	weak ..	good

Figure 7
Rules of organizational level

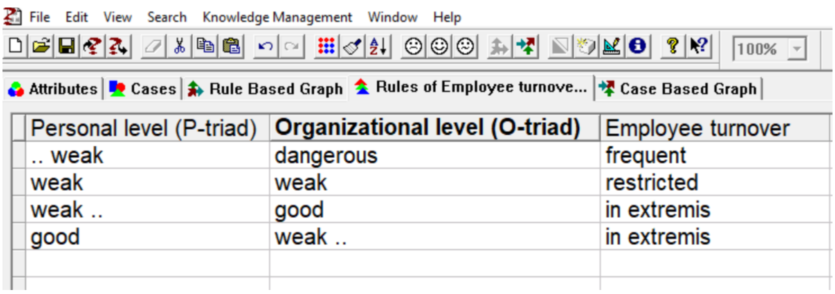
If we assign a value to each attribute that does not conform to the ambiguous formal logic, the system draws attention to the error by adding “mood-indicating faces”. In this case, we need to review each indicated line and find the cause of the error. Basically, these cases can be traced back to two typical problems. One possible reason is that the answer to the given question or concept was incorrectly coded by the expert, in which case the value must be specified for the given attribute. Another possible reason of the fault can be that the given answers of the employee to the asked questions were not consistent.



	Respect	hierarchical	forcible	bilateral
Organizational well-being	Trust			
factious	incorrect measurement	dangerous	.. weak	*
factious	occasional	dangerous	.. weak	*
factious	bilateral	dangerous	*	*
superficial	incorrect measurement	dangerous	.. weak	*
superficial	**occasional**	dangerous	.. weak	*
superficial	bilateral	dangerous	*	*
pleasant	incorrect measurement	.. weak	.. weak	*
pleasant	occasional	.. weak	weak	weak ..
pleasant	bilateral	weak	weak ..	good

Figure 8
Error message about a system rule conflict

Among the rules, the system is able to create complex rules, which are based on the given answers. The monitoring of which can be a great help in a company's decision making process and can indicate the points and problem areas that need more attention during the daily business.



Personal level (P-triad)	Organizational level (O-triad)	Employee turnover
.. weak	dangerous	frequent
weak	weak	restricted
weak ..	good	in extremis
good	weak ..	in extremis

Figure 9
Complex rules

The system also marks separately the points that are irrelevant to the user of the evaluation in terms of the final result. These fields or intersections are marked with “*”. In addition, the system is able to draw the user's attention to points from which each attribute cannot give a worse or better value. These values are marked in the field with “…”.

If Personal-triad is "weak" or worse and Organizational-triad is "dangerous", then Employee turnover is "frequent". From this we see that even the second level (weak) of the Personal-triad gives the least favorable value to the Employee turnover. Following this path, we can also read the other complex rules, but now we present only the last rule, which shows a completely different reasoning at the most favorable outcome than what it showed. The last complex rule is read so that if Personal-triad is "good" and Organizational-triad is "weak" or "good", we get the best result. If we go back to the complex rule in the third row, we can see that it gives the same result as the fourth row.

Conclusions

As a result of our research, we expect that with the improved version of this initial model, we will be able to validate situations from different behaviors that can help us identify situations and critical points that may be important to an organization or company. By creating, applying, and identifying these models, we can identify situations that require intervention more easily and quickly, and our effectiveness can increase as a result. The model can be used to identify and avoid situations that can lead to employee turnover with high certainty, so the identification of it can also play a strategic role in the life of a company.

In our research, we have also formulated numerous limitations. We do not address the question of the level, which level of employee turnover in a company's life can be acceptable. Thus, the model does not give a value judgment on the basis of the recognition of situations and behaviors. Furthermore, the scope of the model was delimited. We deal only and exclusively with work environments and companies as cases to be investigated, which operate as production companies and employ manual workers. We excluded the intellectual workers of the companies from the analysis, because presumably their performance measurement system works differently and the nature of the tasks to be performed is different from the manual workers, therefore the model would not fully reflect the reality, and in this case we could draw erroneous conclusions from them.

Acknowledgement

At the fundament of this research is all the knowledge, observations and experiences what the authors collected as teachers and advisors from daily life and business in the last 20-40 years. The research includes only their own studies, analyses and experiments, in which examination the Doctus expert system helped.

References

[1] Gim, G. C. W., Desa, N. M., Ramayah, T.: Competitive psychological climate and turnover intention with the mediating role of affective commitment, Procedia - Social and Behavioral Sciences, 2015, Vol. 172, pp. 658-665

[2] Shapira-Lishchinsky, O. S., Even-Zohar, S.: Withdrawal Behaviors Syndrome: An Ethical Perspective, Journal of Business Ethics, 2011, Vol. 103, pp. 429-451

[3] Ghetta, A., Hirschi, A., Wang, M., Rossier, J., Herrmann, A.: Birds of a feather flock together: How congruence between worker and occupational personality relates to job satisfaction over time, Journal of Vocational Behavior, 2020, Vol. 119, pp. 103412

[4] Ahrholdt, D. C., Gudergan, S. P., Ringle, C. M.: Enhancing loyalty: When improving consumer satisfaction and delight matters, Journal of Business Research, 2019, Vol. 94, pp. 18-27

[5] Yuan, Y., Fenga, B., Lai, F., Collins, B. J.: The role of trust, commitment, and learning orientation on logistic service effectiveness, Journal of Business Research, 2018, Vol. 93, pp. 37-50

[6] Benson, G. S., Young, S. M., Lawler, E. E.: High-involvement work practices and analysts' forecasts of corporate earnings, Human Research Management, 2006, Vol. 45, pp. 519-537

[7] Batt, R., Cornell, A. C.: An Employment Systems Approach to Turnover: HR Practices, Quits, Dismissals, and Performance, Academy of Management Journal, 2011, Vol. 54, No. 4, pp. 695-717

[8] Kacmar, K. M., Andrews, M. C., Van Rooy, D. L., Steilberg, R. C., Cerrone, S.: Sure everyone can be replaced…but at what cost? Turnover as a predictor of unit-level performance, Academic Management Journal, 2006, Vol. 49, pp. 133-144

[9] Ton, Z., Huckman, R. S.: Managing the impact of employee turnover on performance: The role of process conformance, Organzational Science, 2008, Vol. 19, pp. 56-68

[10] Hausknecht, J., Holwerda, J. A.: When Does Employee Turnover Matter? Dynamic Member Configurations, Productive Capacity, and Collective Performance, Organization Science, 2013, Vol. 24(1), pp. 210-225

[11] Mayer, R. C., Davis, J. H., Schoorman, F. D.: An Integrative Model of Organizational Trust, The Academy of Management Review, 1995, Vol. 20, No. 3, pp. 709-734

[12] Brashear, T. G., Manolis, C., Brooks, C. M.: The effects of control, trust, and justice on salesperson turnover, Journal of Business Research, 2005, Vol. 58, pp. 241-249

[13] Pitesa, M., Thau, S., Pillutla, M. M.: Workplace trust as a mechanism of employee (dis)advantage: The case of employee socioeconomic status, Research in Organizational Behavior, 2017, Vol. 37, pp. 83-101

[14] DeConinck, J. B.: The effects of ethical climate on organizational identification, supervisory trust, and turnover among salespeople, Journal of Business Research, 2011, Vol. 64, pp. 617-624

[15] Allen, M. R., George, B. A., Davis, J. H.: A model for the role of trust in firm level performance: The case of family businesses, Journal of Business Research, 2018, Vol. 84, pp. 34-45

[16] Luthans, F., Youssef, C. M.: Emerging Positive Organizational Behavior, Journal of Management, 2007, Vol. 33, No. 3, pp. 321-349

[17] Koene, B. A. ., Vogelaar, A. L. W., Soeters, J. L. (2002) Leadership effects on organizational climate and financial performance: Local leadership effect in chain organizations, The Leadership Quarterly, Vol. 13, pp. 193-215

[18] Spell, H. B., Eby, L. T., Vandenberg, R. J.: Developmental climate: A cross-level analysis of voluntary turnover and job performance, Journal of Vocational Behavior, 2014, Vol. 84, pp. 283-292

[19] Badayai, A. R. A.: A Theoretical Framework and Analytical Discussion on Uncongenial Physical Workplace Environment and Job Performance among Workers in Industrial Sectors, Procedia - Social and Behavioral Sciences, 2012, Vol. 42, pp. 486-495

[20] Brien, A., Smallman, C.: The respected manager…the organizational social capital developer, International Journal of Hospitality Management, 2011, Vol. 30, pp. 639-647

[21] Rahimi, F., Fallah, S.: Study of Organizational Life Cycle And Its Impact On Strategy Formulation, Procedia - Social and Behavioral Sciences, 2015, Vol. 207, pp. 50-58

[22] Hanaysha, J.: Testing the Effects of Employee Engagement, Work Environment, and Organizational Learning on Organizational Commitment, Procedia - Social and Behavioral Sciences, 2016, Vol. 229, pp. 289-297

[23] Thaler, R. H., Sunstein, C. R.: Nudge, Improving Decisions About Health, Wealth, and Happiness, 2008, Yale University Press

[24] Kahneman, D.: Thinking Fast and Slow, 2012, UK: Penguin Books Ltd

[25] Baranyi, P., Csapó, Á.: Definition and Synergies of Cognitive Infocommunications, Acta Polytechnica Hungarica, 2012, Vol. 9, pp. 67-83

[26] Lakoff, G. P., Johnsen, M.: Metaphors we live by, Afterword 2003 by The University of Chicago, ISBN: 0-226-46801-1

[27] Baracskai, Z., Dörfler, V.: An essay concerning human decisions, Transdisciplinary Journal of Engineering and Science, 2017, Vol. 8, pp. 71-82

[28] Adelman, L.: Measurement issues in knowledge engineering, IEEE Transactions on Systems, Man and Cybernetics, 1989, Vol. 19, pp. 483-488

[29] Liao, S.: Expert system methodologies and applications – a decade review from 1995 to 2004, Expert systems with Applications, 2005, Vol. 28, pp. 93-103

[30] Wagner, W. P.: Trends in expert system development: A longitudinal content analysis of over thirty years of expert system case studies, Expert Systems With Applications, 2017, Vol. 76, pp. 85-96

[31] Sahin, S., Tolun, M. R., Hassanpour, R.: Hybrid expert systems: A survey of current approaches and applications, Expert Systems with Applications, 2012, Vol. 39, pp. 4609-4617

[32] Hatzilygeroudis, I., Prentzas, J.: Integrating (rules, neural networks) and cases for knowledge representation and reasoning in expert systems, Expert Systems with Applications, 2004, Vol. 27, pp. 63-75

[33] Hamada, K., Baba, T., Sato, K., Yufu, M.: Hybridizing a genetic algorithm with rule-based reasoning for production planning, IEEE Expert, 1995, Vol. 35, pp. 60-67

[34] Sabourin, L., Villeneuve, F.: OMEGA, an expert CAPP system, Advances in Engineering Software, 1996, Vol. 25, pp. 51-59

[35] Wu, T. P., Chen, S. M.: A new method for constructing membership functions and fuzzy rules from training examples, IEEE Transactions on Systems, Man, and Cybernetics—Part B: Cybernetics, 1999, Vol. 29, pp. 25-37

[36] Wu, C. H., Lee, S. J.: Enhanced high-level Petri nets with multiple colors for knowledge verification/validation of rule-based expert systems, IEEE Transactions on Systems, Man, and Cybernetics—Part B: Cybernetics, 1997, Vol. 27, pp. 760-773

[37] Higa, K., Lee, H. G.: A graph-based approach for rule integrity and maintainability in expert system maintenance, Information and Management, 1998, Vol. 33, pp. 273-285

[38] Kim, K. H., Park, J. K., Hwang, K., Kim, S. H.: Implementation of hybrid short-term load forecasting system using artificial neural networks and fuzzy expert systems, IEEE Transactions on Power Systems, 1995, Vol. 10, pp. 1534-1539

[39] Zaraté, P., Liu, S.: A new trend for knowledge-based decision support systems design, International Journal of Information and Decision Sciences, 2015, Vol. 8 (3), pp. 305-324

[40] Dawood, N. N.: A strategy of knowledge elicitation for developing an integrated bidding/production management expert system for the precast industry, Advances in Engineering Software, 1996, Vol. 25, pp. 225-234

[41] Keefe, R. M., Preece, A. D.: The development, validation and implementation of knowledge-based systems, European Journal of Operational Research, 1996, Vol. 92, pp. 458-473

[42] Mockler, R. J., Dologite, D. ., Gartenfeld, M. E.: Talk with the experts: learning management decision-making using CAI, Cybernetics and Systems: An International Journal, 2000, Vol. 31, pp. 431-464

[43] Knauf, R., Gonzalez, A. J., Abel, T.: A framework for validation of rule-based systems, IEEE Transactions on Systems, Man, and Cybernetics—Part B: Cybernetics, 2002, Vol. 32, pp. 281-291

[44] Kolonder, J. L.: Case-based reasoning, 1994, New York: Morgan Kaufmann

[45] Baracskai, Z., Velencei, J., Dörfler, V.: Reductive Reasoning, Montenegrin Journal of Economics, 2005, Vol. 64, pp. 59-66

[46] Baracskai, Z. Doctus documentation, www.doctus.hu, 19.08.2020