AI–based approach for forming software customer support teams based on multifactor portraits of candidates' perception subjectification of the support object

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Abstract

The paper is devoted to presentation of the authors' proposed and developed new AI–based approach to the formation of customer support teams for software products, based on a multifactor portraits of candidates' perception subjectification of the support object. The proposed approach is based on the principle of taking into account the factors influencing the perception subjectification of the object of interaction – by the subjects of this interaction, with the subsequent formation of the corresponding personal / individual multifactor portraits of each of the subjects, as well as their comparative analysis when making decisions on the confirmation or rejection of each of the candidates (wishing to join the customer support team of the corresponding supported software product) based on their multifactor portraits. As a part of the research, as well as an example of the practical approbation of the proposed approach, a relevant practical applied problem of selecting the optimal candidate to replace the vacant position of a customer support team employee in place of the previous member who left, has been successfully resolved by using this approach.

Keywords

software product support, impact factors, perception subjectivization of the objects of interaction, multifactor portrait, team formation.

1. Introduction

The modern requirements of the global IT market pose new challenges to software development companies both in the field of direct software development and in the context of ensuring its proper comprehensive support at all stages of the life cycle, one of which is, among other things, customer support for clients, customers and end users of released software products.

At the same time, there are a lot of relevant scientific and applied tasks and problems related to the implementation of an appropriate level of customer support of software clients and end users. One of such tasks is the formation of an effective and efficient, as well as well–balanced, software customer support teams.

From the other hand, another problem – is the need to take into account and research various existing factors of perception subjectivization of customer support objects (which can be both the supported software products themselves as well as the constituent processes of their comprehensive support) by its subjects (participants of software products' customer support teams).

The relevance of this problem lies in the fact that it is actually the perception subjectivization of the interaction object(s) (for example, the supported software product, its comprehensive support processes, or even its direct end users) by the subjects of this interaction – that significantly affects

[*] *CIAW-2025: Computational Intelligence Application Workshop, September 26-27, 2025, Lviv, Ukraine*

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the efficiency and effectiveness of the latter, since the discrepancy in subjective perception (between members of support team, between customers or end users and support team members, between support team members and programmers, etc.) leads to misunderstandings, which, in turn, lead to the significant loss of precious time to eliminate these misunderstandings, negatively affecting competitiveness in the modern global, highly dynamic IT services market.

2. Related works

The review of existing works and researches has been carried out in two key areas, one of which is the area of research on customer support of software products, while the other one is the area of research on team formation. In particular, the basic work [1] covers the issues of IT–support in a rather comprehensive way, revealing an understanding of the main tasks and problems in this area, the elimination of technical and other malfunctions, as well as an effective approach to isolating problems so that they could be effectively resolved with the least disruption and with minimal costs of productivity and available resources. The authors of the work [2] have conducted a literature review devoted to the study of the advantages of using integrated systems in call–centers as one of the key (and, in fact, the first in the chain among all other links of the practical implementation of comprehensive customer support of any software products) links of customer support. The work [3] is devoted to the study of existing literature sources on customer support automation in the context of knowledge management, as well as the development of a theoretical model of automated support systems that uses several methods to assist and automate the process of processing and resolving users' requests. The authors of study [4] dedicate their research to the creation of an intelligent user support assistant as a solution, based on machine learning, and search in a two–level distributed knowledge repository, providing context–sensitive support and taking into account the customers' and users' experience of using the supported software product(s).

The authors of research [5] conducted a comprehensive systematic review of relevant existing works and researches on machine learning approaches in various scenarios of using the request processing function in customer support services, and also provided analytical data on existing limitations of machine learning in this area. In scope of study [6], the authors conducted a review of current trends aimed at determining the current state of technology in the field of automated customer support ticketing systems, according to which the creation of an automated incident management tool is the main topic in this field, followed by escalation of requests and forecasting customer sentiment, and it was also additionally established by the athors of this study that random forest algorithms and the support vector method act as one of the best classification algorithms in this applied field. At the same time, the authors of research [7] presented the architecture of a customer support request processing system to improve the accuracy of their predicted resolution time by performing a step–by–step hot coding of categorical variables and then feature selection, after which a combination of classification and regression models is used in a specialized prediction pipeline, finally concluding that the random forest regression model has the best performance compared to the neural network and ADA boosting models.

In scope of research [8] the author examines the structures, issues, and emerging technologies that improve IT–support for large–scale corporate help desk applications, and also examines best practices for service level agreements (SLAs), lifecycle management, and automation, addressing issues of multi–level complexity, integration of legacy technologies, and data security, additionally assessing indicators and future trends, in addition to artificial intelligence, cloud technologies, and DevOps. In turn, work [9] is devoted to superficial assessment of the effectiveness of artificial intelligence and automation in customer service and support, a study of the level of customer satisfaction, and an analysis of problems associated with the integration of artificial intelligence approaches into this area.

While the paper [10] explores specific obstacles and issues related to data privacy and security, such as: managing complex queries, preserving human influence, reducing algorithmic bias, and

integrating artificial intelligence with existing customer support systems, which also covers strategies aimed at harmonizing efficiency and personalization, as well as future considerations for improving artificial intelligence implementation, with the aim of creating a comprehensive understanding of AI–based customer service for industry professionals and researchers seeking to use artificial intelligence for improving customer service and customer support experiences.

In addition, work [11] emphasizes the importance of the impact of team building and team building principles on the performance of not only these separate or specific teams, but also whole companies in general. At the same time, another work [12] examined, analyzed and discussed teamwork from the point of view of its development stages: the formation stage, the storming stage, the norming stage and the execution stage, exploring the strategic impact of each stage on the other. While the article [13] examines the impact of team building and teamwork in organizations and their consequences for managers and employees, noting that team building stimulates organizational productivity, service quality and overall positive indicators, and also improves organizational development and efficiency, promotes continuous growth, open and positive communication, as well as provides opportunities for development of trust and leadership potential of their participants. Another paper [14] examines the concept of team building and studies the relevant existing literature sources in order to determine whether team building contributes to positive organizational outcomes, contributing to productivity, efficiency, and competitive advantage, noting that organizations use team building to achieve high levels of task performance and human resource support, as well as to stimulate and promote better productivity and innovation(s). At the same time, the authors of [15] examine the issues of forming development teams and attracting new people to existing teams, emphasizing the complete empirical nature of these processes and the absence of a single common and universal method or unique solution for solving these problems.

Thus, the review of existing researches confirms the importance of the issues of both customer support of software products (including, in particular, using advanced artificial intelligence technologies) and the issues of team formation (both in the context of customer support, and in general), while, at the same time, unfortunately leaving out of consideration an important nuance of any intersubjective interaction of all participants in these processes, which is: the perception subjectivization of the object of interaction – by the subjects of this same interaction, which confirms the relevance, importance and the needs of performing additional researches in this direction.

3. Method

Thus, the main goal of the proposed and developed new approach is to ensure the possibility of taking into account and consideration the influence of various relevant existing impact factors, which lead to the perception subjectivization of the object of interaction – by each of the subjects of this same interaction. At the same time, it should be immediately worth noting that the shares of influence of each of the previously declared and agreed upon single set of common impact factors – will differ (to a greater or lesser extent) for each of the subjects of interaction, thereby forming individual, personalized, and somretimes even absolutely unique and quite unrepeatable, multifactor portraits of the latter.

While the impact factors themselves can be absolutely various factors that in one way or another, to one degree or another, influence (and sometimes even distort) the objective reality of the set of input characteristics of the object (with which researched subjects are interacting), which leads to the formation of a subjective perception of this object – by each of the participants (subjects) interacting with it. As a result, each of the subjects of joint (including team communities) interaction with same single (common to all these subjects) object – interacts both directly with this object and with all other subjects, through the prism of their subjective perception of this object. Accordingly, the difference (and sometimes even total incompatibility) in the subjective perception of the same object of interaction can lead to temporary or permanent

misunderstandings between the subjects, which, in turn, has an extremely negative impact on the efficiency, quality, and effectiveness of their joint and common interaction.

In the context of customer support of software products, the factor of perception subjectivization of the object of interaction (for example, a supported software product, or the constituent processes of its comprehensive support, the key of which is customer support of clients and end users) plays a decisive role. That is why the development of an appropriate, presented in the framework of this research, specialized approach to the formation of customer support teams of software products based on multifactor portraits of perception subjectivization of the support object by the candidate(s) is an urgent and quite relevant scientific and applied problem that needs to be solved.

The research [16] represents a specialized impact factors reverse analysis method for software complexes' support automation, where the main principles (of aforementioned method) are outlined in maximum detail. In short, the main idea of that method is to implement the possibility of identifying the share of presence of each of the previously declared set of impact factors on the perception subjectivization of the supported software product or the components of its comprehensive support processes. And in this specific case, the identification of these shares of presence of pre–declared impact factors is carried out on the basis of modeling the corresponding situational cases within the framework of the corresponding pre–designed generalized model of perception subjectivization of the investigated support object with an appropriate encapsulated trained artificial neural network of a multilayer perceptron type.

Thus, by modeling a set of situational cases for one specific researched subject of interaction with the investigated support object, it becomes possible to obtain an appropriate individual (i.e. personalized) multifactor portrait of perception subjectivization of the object of interaction (for example: the supported software product itself, the components of its customer support processes, or even the end users of this supported software product themselves) by this separate specific researched subject (for example: a candidate for the customer support team of a certain supported software product). Therefore, in this case, a multifactor portrait of perception subjectivization of the support object is nothing more than a set of averaged values of the influence shares for each of the impact factors based on a set of resulting values of processing the corresponding situational cases for each individual subject. As for the source of initial data for such situational cases – they are accumulated on the basis of a cognitive analysis of the subject's activities in solving existing problem(s) in the context of supporting a certain software product, namely: what actions were taken by this subject, in what sequence/order they were taken, how the communication with a client/user took place, as well as a number of other additional points, depending on the specific needs.

Expression (1) given below represents a dedicated specizlized developed mathematical model of a multifactorial portrait of any particular interaction subject in the context of its personalized perception of the object of any specific interaction, caused by the influence of previously declared impact factors:

$$SuPor = \left(GF_1; GF_2; \ldots; GF_n\right) = \left(\frac{\sum_{j=1}^{m} F_1^j}{m}; \frac{\sum_{j=1}^{m} F_2^j}{m}; \ldots; \frac{\sum_{j=1}^{m} F_n^j}{m} \right), \quad (1)$$

where $SuPor$ – a multifactor portrait of the research subject; GF_1 – generalized share of influence of the impact factor 1 onto the multifactor portrait of the researched subject; GF_2 – generalized share of influence of the impact factor 2 onto the multifactor portrait of the researched subject; GF_n – generalized share of influence of the impact factor n onto the multifactor portrait of the researched subject; n – total amount of previously declared researched impact factors (common for all subjects, regardless of any specific of them) influencing the perception subjectivization of the investigated object of interaction; F_1 – the share of presence of impact factor 1 (of the specific researched subject's perception subjectivization of the researched interaction object) according to

the modelling results of j–th situational case; F_2 – the share of presence of impact factor 2 (of the specific researched subject's perception subjectivization of the researched interaction object) according to the modelling results of j–th situational case; F_m – the share of presence of impact factor m (of the specific researched subject's perception subjectivization of the researched interaction object) according to the modelling results of j–th situational case; m – total amount of investigated and simulated situational cases of perception subjectivization of the interaction object by the relevant separate specific researched subject.

Figure 1 below describes a flowchart of the developed algorithm for forming software customer support teams based on multifactor portraits of candidates' perception subjectivization of the support object based on the results of the AI approach of existing impact factors reverse analysis method for software complexes' support automation.

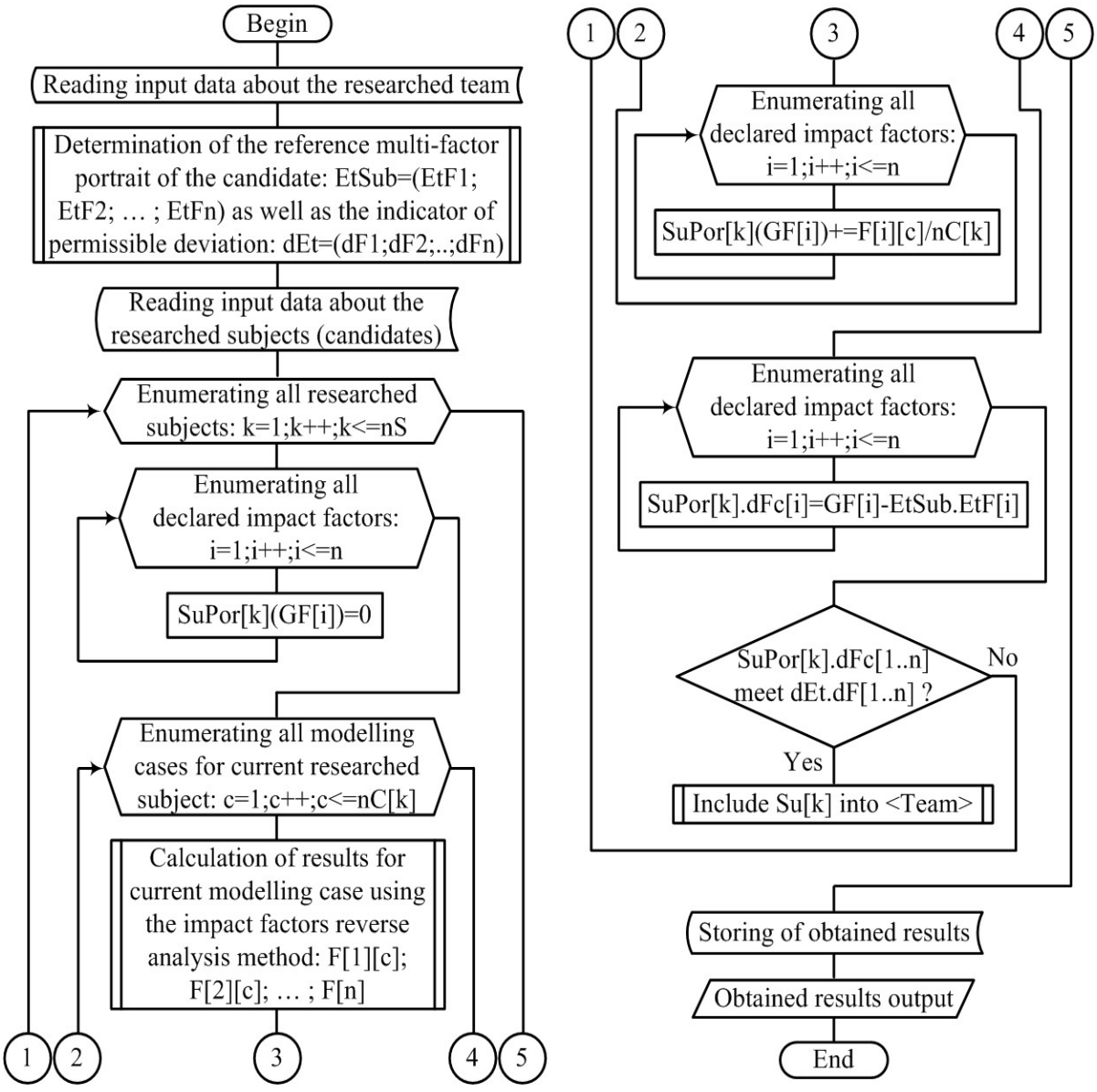

Figure 1: A flowchart of the developed algorithm for forming software customer support teams based on multifactor portraits of candidates' perception subjectivization of the support object.

So, existing impact factors reverse analysis method for software complexes' support automation acts as a fundamental basis of the developed AI approach to forming software customer support teams based on multifactor portraits of candidates' perception subjectivization of the support object.

4. Results of the study

Let's consider the results of the research of the developed AI–based approach (to forming the software customer support teams based on multifactor portraits of candidates' perception subjectivization of the support object) on the example of solving a relevant practical applied problem of selecting the optimal candidate to replace the vacant position of a customer support team employee in place of the previous member who left. In this case, the "reference" multifactor portrait of the candidate would be represented, in fact, by a multifactor portrait of the member who left the existing customer support team. Table 1 below contains data of a multifactorial portrait of the member who left an existing customer support team.

Table 1
Data of a multifactorial portrait of the member who left an existing customer support team

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
Member	0.065	0.238	0.027	0.086	0.085	0.295	0.156	0.048

At the same time, Table 2 below contains data on multifactor portraits of all investigated subjects – candidates for filling the vacant position of a customer support team employee in place of the previous member that left.

Table 2
Data on multifactor portraits of investigated subjects – candidates for filling the vacant position of a customer support team employee

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
Subject1	0.119	0.072	0.061	0.207	0.065	0.149	0.014	0.313
Subject2	0.094	0.016	0.085	0.187	0.178	0.100	0.235	0.105
Subject3	0.296	0.169	0.157	0.031	0.056	0.066	0.135	0.090
Subject4	0.041	0.157	0.078	0.224	0.071	0.083	0.314	0.032
Subject5	0.092	0.052	0.039	0.211	0.222	0.201	0.109	0.074
Subject6	0.183	0.102	0.020	0.018	0.125	0.190	0.277	0.085
Subject7	0.054	0.195	0.174	0.221	0.036	0.067	0.160	0.093
Subject8	0.036	0.027	0.068	0.208	0.309	0.175	0.064	0.113
Subject9	0.228	0.053	0.102	0.020	0.057	0.208	0.133	0.199
Subject10	0.079	0.036	0.055	0.063	0.260	0.073	0.103	0.331
Subject11	0.027	0.213	0.127	0.137	0.043	0.086	0.336	0.031
Subject12	0.114	0.231	0.194	0.034	0.118	0.181	0.110	0.018
Subject13	0.116	0.195	0.092	0.124	0.051	0.138	0.148	0.136

Subject14	0.037	0.144	0.115	0.277	0.069	0.029	0.013	0.316
Subject15	0.012	0.185	0.149	0.249	0.018	0.037	0.207	0.143
Subject16	0.143	0.389	0.037	0.009	0.038	0.168	0.059	0.157
Subject17	0.048	0.333	0.141	0.013	0.029	0.136	0.067	0.233
Subject18	0.285	0.119	0.239	0.018	0.068	0.015	0.109	0.147
Subject19	0.248	0.091	0.108	0.029	0.163	0.022	0.031	0.308

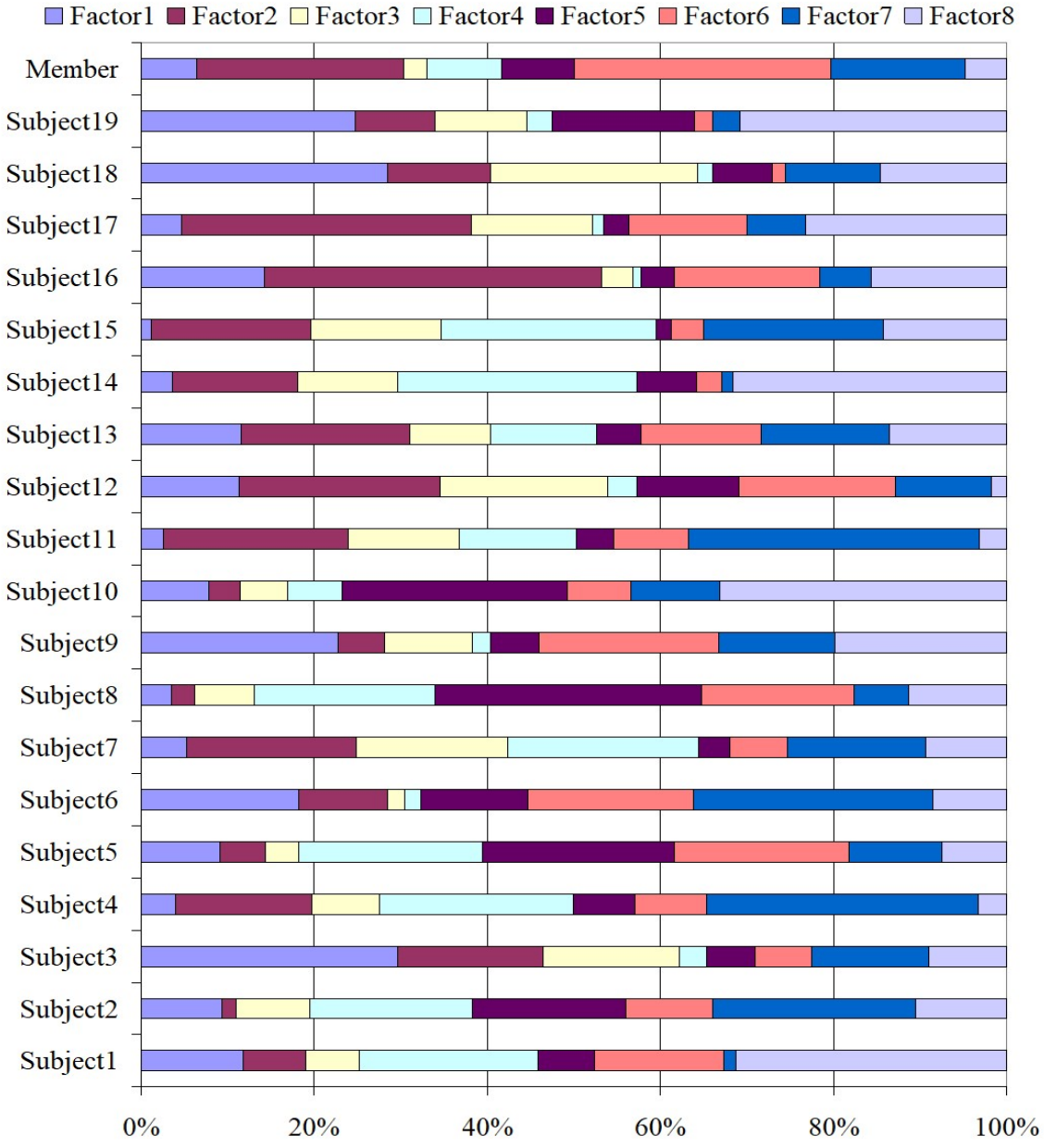

Figure 2: A graphical interpretation of multifactor portraits of investigated subjects – candidates for filling the vacant position of a customer support team employee in place of the previous member who left, as well as multifactor portrait of that specific member.

In addition, Figure 2 below demonstrates a graphical interpretation of multifactor portraits of investigated subjects – candidates for filling the vacant position of a customer support team employee in place of the previous member who left, as well as multifactor portrait of that specific member. Table 3 below provides comparative characteristics data (by each of the declared impact factors) between each investigated subject (candidate for filling the vacant position of a customer support team member) and the departed member who left the team.

Table 3
A comparative characteristics data (by each of the declared impact factors) between each investigated subject (candidate for filling the vacant position of a customer support team member) and the departed member who left the team

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
d(Subj.1–Memb.)	0.054	−0.166	0.034	0.121	−0.020	−0.146	−0.142	0.265
d(Subj.2–Memb.)	0.029	−0.222	0.058	0.101	0.093	−0.195	0.079	0.057
d(Subj.3–Memb.)	0.231	−0.069	0.130	−0.055	−0.029	−0.229	−0.021	0.042
d(Subj.4–Memb.)	−0.024	−0.081	0.051	0.138	−0.014	−0.212	0.158	−0.016
d(Subj.5–Memb.)	0.027	−0.186	0.012	0.125	0.137	−0.094	−0.047	0.026
d(Subj.6–Memb.)	0.118	−0.136	−0.007	−0.068	0.040	−0.105	0.121	0.037
d(Subj.7–Memb.)	−0.011	−0.043	0.147	0.135	−0.049	−0.228	0.004	0.045
d(Subj.8–Memb.)	−0.029	−0.211	0.041	0.122	0.224	−0.120	−0.092	0.065
d(Subj.9–Memb.)	0.163	−0.185	0.075	−0.066	−0.028	−0.087	−0.023	0.151
d(Subj.10–Memb.)	0.014	−0.202	0.028	−0.023	0.175	−0.222	−0.053	0.283
d(Subj.11–Memb.)	−0.038	−0.025	0.100	0.051	−0.042	−0.209	0.180	−0.017
d(Subj.12–Memb.)	0.049	−0.007	0.167	−0.052	0.033	−0.114	−0.046	−0.030
d(Subj.13–Memb.)	0.051	−0.043	0.065	0.038	−0.034	−0.157	−0.008	0.088

d(Subj.14–Memb.)	−0.028	−0.094	0.088	0.191	−0.016	−0.266	−0.143	0.268
d(Subj.15–Memb.)	−0.053	−0.053	0.122	0.163	−0.067	−0.258	0.051	0.095
d(Subj.16–Memb.)	0.078	0.151	0.010	−0.077	−0.047	−0.127	−0.097	0.109
d(Subj.17–Memb.)	−0.017	0.095	0.114	−0.073	−0.056	−0.159	−0.089	0.185
d(Subj.18–Memb.)	0.220	−0.119	0.212	−0.068	−0.017	−0.280	−0.047	0.099
d(Subj.19–Memb.)	0.183	−0.147	0.081	−0.057	0.078	−0.273	−0.125	0.260

In addition, Figure 3 below shows a graphical interpretation of the comparative characteristics (by each of the declared impact factors) between each investigated subject (candidate for filling the vacant position of a customer support team member) and the departed member who left the team.

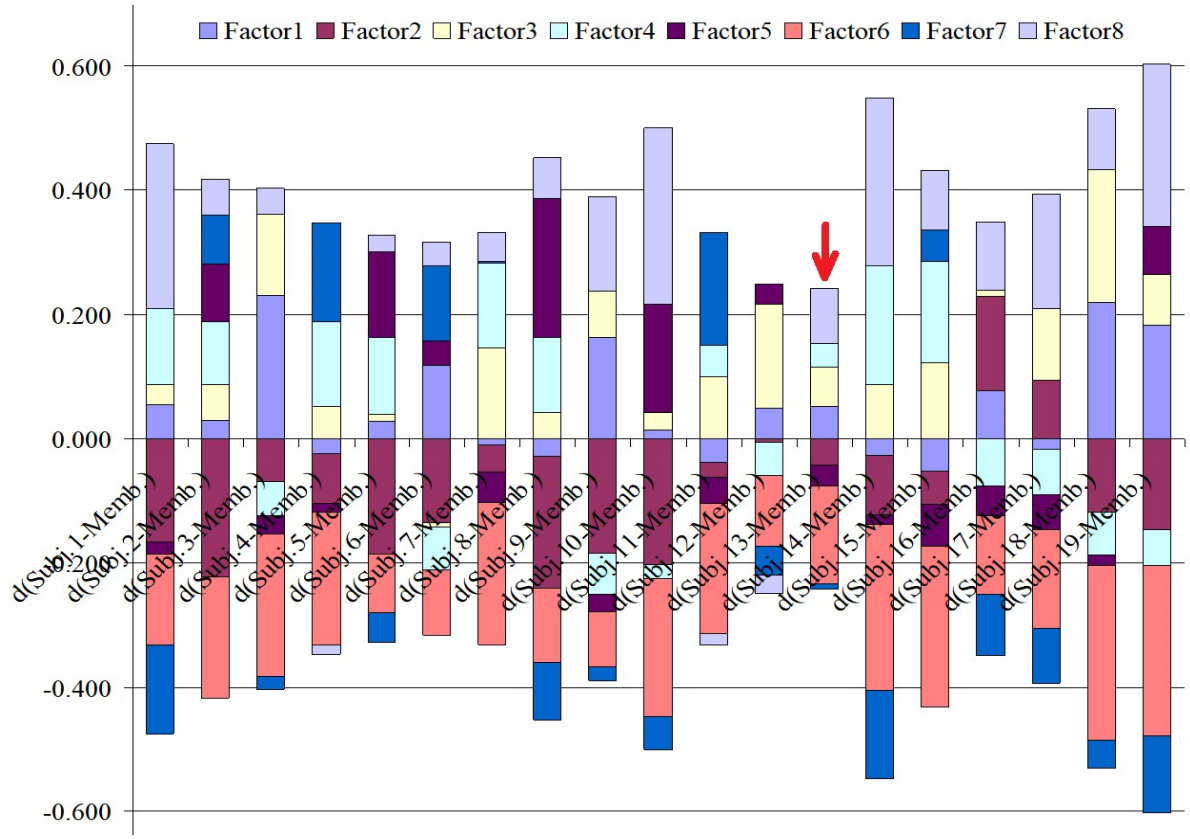

Figure 3: A graphical interpretation of the comparative characteristics (by each of the declared impact factors) between each investigated subject (candidate for filling the vacant position of a customer support team member) and the departed member who left the team.

Thus, as can be observed from Figure 3, the candidate subject with sequencial number 13 actually appeared to be the most optimal candidate for replacing the vacant position of a customer

support team employee in place of the previous member who left, since its deviation of the multifactor portrait (in total by all declared impact factors) is minimal relative to the multifactor portrait of the member who left. Thus, the results obtained during the practical approbation of the developed approach (to forming software customer support teams based on multifactor portraits of candidates' perception subjectivization of the support object) on the example of solving a relevant practical applied problem (of selecting the optimal candidate to replace the vacant position of a customer support team employee in place of the previous member who left) confirm the effectiveness of the proposed approach, as well as its potential in solving a number of other similar problems in the context of team building in the field of customer support, as well as within the framework of any intersubjective interaction in general (regardless of applied area of this interaction).

5. Discussions

In work [17] authors investigate the issues of recruiting, as well as the process of team formation, in IT companies using general scientific, interdisciplinary, economic and mathematical, statistical and special methods, such as, in particular: a system approach, statistical grouping, graphic analysis, selective observation, which act as the theoretical and methodological basis of the study, which, however, unfortunately, do not take into account the factor of the perception subjectivization of the object of interaction by the subjects of this same interaction while forming these IT teams.

At the same time, in the framework of work [18], the authors considered the issue of developing a complex models for increasing the objectivity of the role assessment of the competencies of applicants while recruiting specialists for an IT companies in conditions of uncertainty on the platform of fuzzy sets, using, in particular, such theoretical methods of scientific knowledge as: the method of information synthesis and analysis, the statistical method, the maximization method and the Max–disjunction method; and also linguistic variables are given, as well as the basis of fuzzy production rules and the dependencies establishment between the output variable and the input data of the developed fuzzy model, which, unfortunately, does not take into account the factor of perception subjectivization of the applicants.

At the same time, the authors of research [19] investigate the aspect of team formation for IT–field of cyber operations support, which is the first step in creating scalable structures for forming cohesive, effective and balanced teams for conducting successful cyber operations support, using special software for personality profiling, taking into account the quality and timeliness of the output results after each cyber operation completion, team dynamics and the level of performance of cybersecurity and cyber forensics tasks, creating a solid basis for the researchers' hypothesis that creating teams based on individual profiles leads to better balance in the team and, therefore, to higher productivity in performing tasks related to cybersecurity, compared to teams created only on the basis of family ties or personal affiliation, which, however, like in previous studies, unfortunately does not take into account the factor of perception subjectivization of the subjects within the framework of their researched individual profiles.

In another research [20], the authors presented a practical tool for team formation that allows controlling the diversity of team members and the similarity between teams based on pre–selected characteristics of candidates (using students as an example of such candidates), using input data in the form of individual ratings of candidates for various characteristics, as well as specifications of team size ranges, additionally taking into account the order of importance and the goal of diversity of each characteristic that needs to be achieved in teams, i.e. heterogeneity or homogeneity, solving a lexicographic linear programming problem with mixed integers, the result of which is the distribution of candidates across teams that satisfies the given sizes and optimizes the diversity goals in a given order, while promoting similarities between teams, taking into account diversity criteria for both numerical and categorical characteristics, but unfortunately – not taking into consideration the factor of perception subjectivization of the candidate.

Therefore, unlike existing solutions, the proposed AI–based approach, presented in this research, and developed for the purposes of formation a customer support teams (for supported software products) based on multifactor portraits of candidates' perception subjectivization of the support object – ensures the possibility of taking into account and consideration the factor of perception subjectivization of the support object(s), which plays a critical role in the context of ensuring the necessary level of mutual understanding between the participants in the component processes of comprehensive support of software products, one of the key ones being a customer support.

Conclusions

A nowel AI–based approach to forming software customer support teams based on multifactor portraits of candidates' perception subjectivization of the support object has been developed and described in this research. The proposed approach is based on the principle of taking into account the factors influencing the perception subjectivization of the interaction objects – by the subjects of this same interaction, with the subsequent formation of the corresponding personal multifactor portraits of each of the subjects, as well as their comparative analysis when making decisions on the confirmation or rejection of each of the candidates (wishing to join the given customer support team of the corresponding supported software product) based on their multifactor portraits. A mathematical model of a multifactorial portrait of any particular interaction subject in the context of its personalized perception of the object of any specific interaction, caused by the influence of previously declared impact factors, has been developed, as well as a specialized algorithm for forming software customer support teams based on multifactor portraits of candidates' perception subjectivization of the support object based on the results of the AI approach of existing impact factors reverse analysis method for software complexes' support automation. The proposed approach has been ssuccessfully approbated on the example of solving a relevant practical applied problem of selecting the optimal candidate to replace the vacant position of a customer support team employee in place of the previous member who left. While the obtained results of approbation confirm the effectiveness of the proposed approach, as well as its potential in solving a number of other similar and relevant problems in the context of team building in the field of customer support, as well as within the framework of any intersubjective interaction in general, which could be used as a prospect for further researches.

Declaration on Generative AI

The authors have not employed any Generative AI tools.

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