Toward Cognitive Management Accounting

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Received: 6 May 2020; Accepted: 17 June 2020; Published: 23 June 2020

Abstract: This paper examines the impact of cognitive technologies in management accounting. The purpose of the research was to create the current management accountant skills model. The main contributions of this paper are the literature study of the future of management accounting, the study of the impact of cognitive technologies on management accounting, the labor market research, and the current management accountant skills model. The purpose of the literature study was to highlight the opportunities and challenges of the application of cognitive technologies to management accounting and the role of cognitive abilities in the management accountant profession. The labor market study was conducted in order to analyze the impact of cognitive technologies on the management accountant profession and identify the core skills required. The paper fulfills the research gap regarding the impact of cognitive information technologies on management accounting and the management accountant profession in terms of smart and sustainable organization conception. The number of job positions with cognitive analytic skills, big data skills, cognitive abilities, and additional skills and competencies was identified. Although the research reveals differences in the demand for skills and abilities among the studied countries, the common skills model for managerial accountants was successfully created.

Keywords: cognitive computing; managerial accounting; management; big data; skills model; labor market

1. Introduction

Currently, accounting business processes are undergoing a transformation through digitalization and sustainability.

The sustainability of an enterprise is largely determined by the level of innovation potential, especially in the process of development of smart sustainable cities. Nowadays, the convergence of two conceptions, the smart city and the sustainable city, generate the data-driven smart sustainable city. The smart sustainable city consists of smart sustainable organizations, which are based on smart sustainable processes supported by cognitive and big data technologies. These organizations need to find sustainable solutions to deal with the complexity of financial and accounting data. Advances in Internet technologies have made it possible to gather, store, and process large amounts of interactive enterprise data [1]. When creating smart sustainable cities, big data and cognitive technologies generate useful information and insights for citizens, enterprises, and policymakers. The new digital technologies link big data and cognitive analytics with operational sustainability practices for sustainable business management. Transforming large amounts of data into knowledge allows them to empower cognition as well as support decision-making routines [1]. According to the IBM company, “the opportunities that cognitive Internet of Things solutions can deliver in the sustainability space are enormous, and early adopters are gaining a competitive advantage. As sustainability moves into the mainstream on Wall Street, organizations that are able to harness the power of cognitive technologies to advance their goals while helping the planet will lead the way” [2].
The background analysis indicates that accounting for sustainability entails the reporting of ecological and social information and the integrated reporting of sustainability information along with financial reporting. Moreover, the emerging technologies should provide users with sustainability reports, auditing, and the assurance of sustainability information, sustainability implications of financial failure, accounting, and auditing failures.

For years, scientists have emphasized the role of cognitive abilities in behavioral accounting, judgments, and decision making [3–10]. Individuals with good cognitive abilities are better equipped to acquire the knowledge needed to perform their jobs at the highest levels [11].

In recent years, the impact of cognitive abilities on different professions in the finance and accounting sphere has increased. On the other hand, some people are unwilling to recognize the importance of increasing the level of cognitive abilities for a better use of information technologies. The number of works in which scientists attempt to analyze the impact of cognitive skills and cognitive technologies is also constantly increasing.

For years, various definitions of cognitive abilities have been proposed, from the more common to the more concrete. For example, Carroll’s definition states that “cognitive ability can be defined as variation across individuals in the successful performance of tasks primarily involving processing of mental information” [12]. According to one of the most recent definitions, “cognitive abilities are aspects of mental functioning, such as memorizing and remembering; inhibiting and focusing attention; the speed of information processing; and spatial and causal reasoning” [13].

In this paper, cognitive abilities are treated in more practical terms. They are the cognitive skills required by an employee to use cognitive technologies more efficiently and in order to increase the effectiveness of accounting processes, including the acceleration of decision-making processes.

Originally associated with artificial intelligence, the researchers began to use the term “cognitive computing” from the 1990s. Cognitive computing has attracted real attention since 2011.

Cognitive computing refers to the computer systems inspired by the human brain, which have natural language processing capability, learn from experience, interact with humans in a natural way, and help make decisions based on learning processes [3–16].

Cognitive computing can also help accountants with deep analytics. According to Deloitte, “cognitive analytics” is a term used to describe “how organizations apply analytics and cognitive computing technologies to help humans make smarter decisions” [17].

In 2017, John Baron, Managing Director of the professional segment of the Tax and Accounting Business in Thomson Reuters, argued that “very soon, cognitive computing will begin to impact the accountant profession. It can be used in risk mining, grouping and connecting entities, detecting abnormalities in structured and unstructured data, and improving the user experience” [18].

Moreover, in 2019 Forbes wrote that “the use of cognitive technologies already has changed the accounting profession. Automated solutions make the accountant’s job easier, eliminating much of the manual processing of data. Such tools also provide transparency into digitized financial data to validate the quality and accuracy of ledgers, compressing the margin of error” [19].

In recent years, the convergence of Big Data and Artificial Intelligence (AI) in finance and the accounting area is gaining popularity. Cognitive Analytics relates to Big Data technologies. “With the advent of big data, which grows larger, faster and more diverse by the day, cognitive computing systems are now used to gain knowledge from data as experience and then generalize what they have learned in new situations” [20].

However, many accountants are wondering if Artificial Intelligence will be a job-killer in the accounting profession. Most firms believe cognitive computing will be a “job-creator, relieving accountants of time-consuming and mundane process work and freeing up space to work on more complex work” [21]. Scientists suggest that accounting is a business field that is “likely to be augmented by IT technology rather than fully automated” [22].

According to Jim Boomer, “it will serve as a complement to the evolution of accountants from technical advisors to strategic, value-added advisors”, which does not mean that cognitive computing does not present any risks to the accountant profession [21]. The experts suggest that managers will need to transform and expand their practice toward more advisory services. The
commonality between research on human cognitive processes and auditing is usually described with regard to two issues: judgment and risk [23]. The importance of using these capabilities, especially for managers and auditors, is confirmed by many scientists. Accountants should also consider the directions in which they can enhance their knowledge and skills to prepare for the big data challenge [23,24]. Financial and accounting managers, as the leaders and advisors, should maximize their big data analytics skills [25–27].

In the literature on sustainable development, there is still a gap in the impact of modern information technologies on management accounting, and on the achievement of sustainable development by enterprises. These technologies are predominantly cognitive and big data technologies. Moreover, there is no research into the desired skills and abilities of management accountants in practice. In order to analyze the impact of cognitive technologies on managerial accounting, a literature study has been conducted.

The main contributions of this paper are the literature study on the future of management accounting and on the impact of cognitive technologies on management accounting, the labor market research, and the current management accountant skills model.

Since two methodological approaches were chosen, namely a theoretical and a practical approach to the management accountant skills model creation, the literature study was focused on scientific papers and non-scientific literature sources, such as market reports and experts’ opinions.

Most of the papers in this area are based on a qualitative approach, by analyzing the experts’ opinions. In this paper, the quantitative approach of labor market analysis was selected to fulfill the research gap in the area of management accounting skills analysis; therefore, the results of the present study have meaningful practical implications.

The paper is structured as follows. First, a review of the literature is provided, outlining the issues raised by the research on the impact of cognitive technologies on management accounting and the management accountant profession in terms of sustainability. This is followed by a survey conducted on selected labor markets and the description of the results of that survey. The research aimed to create the current management accountant skills model, with an emphasis on modern Information Technologies (IT). Finally, conclusions and future perspectives are presented.

2. Literature review

2.1. The future of Management Accounting

There has been a substantial degree of research interest on the description of the current and future models of management accountant skills. However, the authors concentrate only on the general domain or traditional technologies, without taking into consideration the smart sustainable enterprises conception, supported by cognitive and big data technologies. Moreover, the conducted studies were based on the experts’ opinion analysis. There is a lack of research based on labor market analysis.

The literature review was divided into three groups: papers describing the role of management accounting for sustainable business management, papers describing the changing role of information technologies for management accountants in commercial enterprises, and, finally, papers describing the role of cognitive and big data technologies in sustainable development.

Nowadays, many authors treat management accounting as part of a sustainable development strategy. Most of them initiate the discussion on the further development of management accounting establishing how current management accountants view their present and future role [28–36].

Already in 2004 [28] authors emphasized the extension of the role of management accountants to team leadership, leadership in using statistical/analytical techniques, the design and management of information systems, and the design and control of performance measurement systems.

In paper [32], a bibliometric analysis based on the scientific papers in the Web of Science database concerning management accounting research in Central and Eastern European countries in 1945–2017 was done. It reveals key trends in changes in the field of management accounting research.
The results undergo many political, structural, social, and economic changes, with growing public awareness of the need for corporate sustainability among them.

The paper by Maas and others addresses the question of how companies can and do integrate sustainability assessment, management accounting, management control, and reporting [33].

In 2018, in the book “The Role of the Management Accountant: Local Variations and Global Influences” [35], the future of management accountants in different countries was presented: the United States, United Kingdom, South Africa, Japan, India, France, Canada. The role of IT in management accounting was also described. Most of authors emphasize the increasing role of information technologies in the studied countries. They highlight the importance of interpersonal and technical skills development. They also discuss sustainability as a fundamental challenge for management accountants. The authors state that management accountants are challenged to redefine and develop their role as the coordinators of processes for the management of sustainability information. The skills need to be developed to address sustainability issues. Therefore, educational and training programs should be changed.

In his paper, Gary Cokins describe seven trends of management accounting and, among them, management accounting’s expanding role regarding managing information technology and shared services as a business [36]. He also noticed the shift toward predictive accounting.

In [30], the authors describe how social and environmental accounting and environmental management reporting contribute to more sustainable value.

Others highlight the increasing role of reporting in managerial accounting [37–41]. They also emphasize the importance and value of sustainability reporting. The Bulletin of the United States Bureau of Labor Statistics in 2002 highlights the role of IT for the managerial accounting profession [38].

In his paper “The state and development trends of management accounting in the global environment”, Bartłomiej Nita presents the development trends of management accounting practice in a global environment. He highlights the role of IT in management accounting, especially the role of business intelligence and big data reporting in Enterprise Resource Planning (ERP) systems [39].

Paper [40] provides theoretical as well as practical contributions to the change of the management accounting role in the era of digital technologies. The report created by Louise Ross and Ivan Kovachev presents management accounting tools useful for today and tomorrow [41]. Unfortunately, this report does not take IT tools into consideration. However, it emphasizes the increasing role of reporting.

In recent years, several researches have been conducted in order to analyze the use of Information Technology in management accounting and the potentials and drawbacks of adopting IT in management accounting [42,43].

The relevant report associated with the use of information technologies in the management accounting profession is created by the Institute of Management Accountants and presented as the Management Accounting Competency framework [43]. Unfortunately, there is a lack of focus on cognitive technologies and cognitive abilities in it. The framework contains information about the core competencies divided according to expertise level, from the basic to the expert level. The main management accountant IT competencies are: recommending and implementing the appropriate system in a complex environment, ensuring the integration of information and performance management systems, designing Enterprise Resource Planning workflows for sound financial control, creating customized reports, analyzing data using business intelligence software, leading the organization’s adoption of new technology platforms as they emerge, creating flowcharts using specialized software tools, and using spreadsheet functions (e.g., graphs, filtering and sorting data, importing data, pivot tables) [43].

In the paper by Handley, the convergence of cognitive computing and sustainability is described [44]. The new way of looking at sustainability was presented by B. Barzon in the article “Cognitive sustainability in Digital Experiences” [45]. She describes the conception of cognitive sustainability supported by information technologies.
A significant amount of papers was written about smart sustainable cities [46–56]. These papers also underline the irreplaceable role of cognitive technologies and big data technologies for sustainable smart cities. Smart Sustainable Cities use these technologies to be more intelligent and efficient in enterprise resource management. The authors assure that Artificial Intelligence (AI) and cognitive technologies can help companies use real-time insights and enhance their sustainability efforts [1,44].

2.2. Cognitive Technologies in Managerial Accounting

As previously mentioned, Artificial Intelligence can help companies use real-time insights to enhance their sustainability efforts [44]. Artificial Intelligence has already enabled advanced financial analytics [57]. Tax systems completed with AI are smarter, not only in guiding accountants through the calculations and highlighting areas they might need to review, but also in providing advice and guidance to the client [58]. “Accountants are not required to do detailed research work, as that is done through artificial intelligence” [59]. Analytics introduce the benefits of efficiency in mass data collection and the potential to locate tax evaders [60]. The Internal Revenue Service (IRS) has indicated that it will continue to invest in data technologies to identify tax return errors and address issues with taxpayers as early as possible [60,61].

In turn, Baron argued that “the future of cognitive computing will revolutionize the accounting processes” [18]. Because audit judgment skills are typically developed and refined through years of experience, training, and interaction, the cognitive and big data technologies can harness these judgments from across thousands of audits to aid continuous, real-time auditing [18].

Digital cognitive assistants are helpful when users need to process data from a large number of knowledge sources. Cognitive assistants are often speech-enabled technologies that understand voice commands, recognize a conversation’s context, and answer questions in a personal manner [62,63]. “Digital assistants support the complicated accounting tasks, including responding to common queries around billing and cash flow management, and even searching accounting policies and procedures and calling subject matter experts in the organization to get the appropriate information” [64]. Cognitive assistants can provide interactive decision support for information retrieval and risk assessment in the audit brainstorming sessions. On the other hand, users should be able to manage and monitor modern technologies, so they will have more time to focus on more complex, higher-risk, and strategic tasks [65].

Currently, many companies have already applied cognitive analytics in managerial accounting. “Forward-looking Certified Public Accountant (CPA) firms are investing heavily in emerging technologies” [18]. “Audit firms have nowadays been investing many resources into AI-related projects” [63,64,66]. KPMG company signed an agreement with IBM company to apply IBM Watson to a series of audit processes [63,67]. KPMG has also announced plans to apply IBM’s Watson cognitive computing in other departments, for example the Human Resources department. “This technology gives the ability to analyze a large amount of data, giving them enhanced insights into their client’s financial and business operations, drawing conclusions regarding client’s tax statements and returns” [68]. KPMG’s cooperation with Watson tries to develop selected cognitive services designed to help KPMG “meet its extensive audit-specific security, confidentiality, and compliance requirements” [64,69]. Deloitte is trying to assemble different cognitive capabilities from various vendors and integrate them to support audit processes, such as document review and predictive risk analytics [64,70]. PricewaterhouseCoopers and EY are increasing their usage of audit platforms and predictive analytics [64]. Additionally, the American Institute of CPAs and Rutgers Business School have partnered on a research initiative to advance the use of analytics in auditing [71].

However, most firms do not have access to the capital required to make large-scale investments in technologies like cognitive computing [18].

To manage and monitor advanced technologies, management accountants need to have high cognitive abilities in order to solve strategic tasks. To use cognitive analytic tools, managers need to constantly develop their cognitive abilities. Over the years, scientists and market experts have emphasized the importance of using cognitive skills in managerial positions [72].
2.3. The Role of Cognitive Abilities in the Managerial Accounting Profession

Using cognitive technologies frequently requires management accountants to possess cognitive analytics skills.

According to the Institute of Management Accountants (IMA), “Management accounting is a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization's strategy” [73]. Management accountants are responsible for managing the team. Therefore, they are expected to exhibit excellent leadership skills, conduct performance evaluations, provide mentoring and training on technical skills, conduct regular meetings, and provide guidance based on the directives and strategies given by management [74].

The knowledge of different accounting systems is also included in a management accountant’s duties, with main modules like general ledger, accounts payable, accounts receivable, cash flows, and revenue reconciliation, among others [74]. Forecasting and preparing the yearly budget are also included in a management accountant’s responsibilities. A management accountant prepares periodic closing and management reports that help the executive team with their strategic planning. Finally, a management accountant is responsible for preparing the company’s financial statements and auditing the accounting data of the different departments of the organization.

The management accountant is also expected to exhibit high cognitive abilities. Researchers also underline the importance of these abilities in practice. According to one of the most popular job searching web portals, Indeed.com, cognitive skills are “the ways that your brain remembers, reasons, holds attention, thinks, reads, and learns” [73].

According to Lachman, “cognitive abilities are key competencies that are needed to meet the challenges of job demands, education, and advanced training and a key selection criterion for entry into many elite professions [75]. The cognitive ability could also be defined as a “general mental capability involving reasoning, problem-solving, planning, abstract thinking, complex idea comprehension, and learning from experience” [76].

According to experts, cognitive abilities are especially meaningful in auditing. Studies on cognitive abilities in auditing use the lens model [77], Bayesian statistics and the literature on heuristics and biases [78], analysis of variance techniques [79], descriptive variants of expected utility theory, learning and memory processes [80,81], and various aspects of process tracing methodology [82]. Later, Frederick analyzes how auditors encode knowledge in memory and the implications this might have for the construction and use of memory aids in auditing [83].

The paper of J. Dillard presents the discussion on the relevance of cognitive science to decision-making research in accounting [84].

The paper of Choo presents a major concept from social cognition called “script” and applies this notion to auditing and accounting behavior [85].

In 1992, Libby and Lipe investigated how the performance-related incentive effects of monetary payments depend on the cognitive processes involved in accounting judgment tasks [86]. They argue that this dependency exists.

J. Amernic describes another cognitive ability needed for accounting managers – cognitive complexity: “leaders in the accounting profession have cited the need for accountants to be able to function professionally in a complex and changing environment. The literature of cognitive development suggests that such individuals must possess a high level of cognitive complexity” [87].

Some authors examine the effects of adaptive/innovative cognitive style and professional development on the initiation of radical and non-radical innovations by individual management accountants [88].

Further research involved the use of cognitive tests, cognitive reflection tests, and magnetic resonance imaging to analyze brain work during the accountants’ decision making process [89,90].

In 2016, researchers underlined the role of cognitive reflection abilities in accounting and proved that managers’ decisions, analysts’ recommendations, auditors’ reports, and professors’ lessons tend to be highly influenced by cognitive reflection abilities [3].
Summarizing the results of the literature study, management accountants need to collect, extract, and analyze the information from extensive databases. So, among cognitive abilities, they need to acquire advanced IT skills. This will result in a link to the skills of data extraction, information management, processing of a large amount of data, pattern recognition and privacy, and security management, and will bring new challenges to the labor market. The 2016 survey revealed that 59 percent of employers say data science and analytics skills will be necessary for accounting managers by 2020 [58].

The experts noticed that nowadays there is also a growing need for accounting students to learn financial and accounting data analysis and reporting in order to enhance their abilities [19]. This reveals the labor market’s need to recruit the new generation of managers in the accounting sphere. The universities should be prepared, offering education courses that meet market needs for new specialists. In 2016, it has been noted that many accounting programs do not currently prepare students for such roles [71, 91].

Wang and Wang predicted in 2016 that the accounting managers’ skills needed for the next decade will be: knowledge of data extraction tools in the mining of business intelligence; use of tools that support data modeling and analysis; knowledge management skills; project management skills; change management skills; knowledge of new approaches to funding and product development; ability to use technology to attract, develop, and manage talent; knowledge of emerging payment platforms; better working knowledge of connectivity and IT security; knowledge on how applications integrate [92].

Summarizing all of the above, the main directions of the management accountant profession’s transformation are related to digitalization, sustainable development, big data, cognitive computing, cloud computing, and cognitive abilities development.

Furthermore, the situation should also be analyzed in practical terms. What does the situation look like in local labor markets? Are enterprises already looking for qualified management accountants with cognitive analytics skills and big data knowledge and experience?

To check the current situation in labor markets, a study of the current demand for management accountants’ positions was conducted.

3. Materials and Methods

The research was conducted in November-January 2019. First, data were collected at the beginning of November, and after that results have been checked two times until the beginning of December, during a 1-month period. A similar procedure was conducted in December and January. The empirical research was conducted according to the framework presented in Figure 1. The quantitative approach was selected to fulfill the research gap in the area of management accounting skills analysis.

The labor markets of the selected countries were examined. The goal was to compare the demand for management accountant positions in different continents and countries according to the following criteria: differentiation in GDP level, labor force, IT development level, geographical position (different continents and different European regions), population differentiation. The 5 following countries were taken into consideration: the United States of America, Canada, Poland, the United Kingdom, and Ukraine.
At the beginning, the most popular job search websites were selected, and their comparison was carried out. The following selection criteria were used: 1) the largest number of current management accountants posts, 2) ability to provide “advanced search” with the finding options, which allowed us to search for specific key words within the job posts’ textual content, 3) applicability in studied countries. Consequently, the “Indeed” job search website was chosen.

About 33 of thousands of job posts were analyzed. For all selected countries, the same research procedure was used. To filter the job posts, the website searching mechanism was used. For this purpose, the following keywords were entered in the webpage search field: “cognitive”, “analytics”, “cognitive analysis”, “Cognos”, and also “big data”, “large data”, “large data sets”, “large amounts of data”, etc. For skills analysis, “cognitive skills” and “cognitive abilities” key words were used. For position analysis, the following key words were primarily used: “management accountant”, “accounting manager”, “managerial accountant”, and similar.

The website searching mechanism found many relevant positions, such as: Accounting Manager, Senior Accounting Manager, Manager Accounting and Reporting, Department Budget Manager, Cost Accounting Manager, etc.

Based on the list of obtained, the number of job offers for management accountants (MA) and relevant positions containing cognitive skills requirements, cognitive analytics skills, and big data skills requirements was calculated. The results are presented in Table 1. After that, the additional core competencies were identified by using the following key words: “Project management”, “Business process management”, “Change management”, “ERP” [93], etc.

| Skill                 | USA | Canada | UK  | Poland | Ukraine |
|----------------------|-----|--------|-----|--------|---------|
| Cognitive A skills   | 719 | 36     | 57  | 3      | 0       |
| Big data skills      | 652 | 38     | 60  | 4      | 3       |
| Cognitive skills     | 10 (173) | 10   | 3   | 0      | 0       |
| Total                | 18398 | 5272  | 9019| 563    | 596     |

Table 2. The number of job offers for selected labor markets in December 2019.

| Skill                 | USA | Canada | UK  | Poland | Ukraine |
|----------------------|-----|--------|-----|--------|---------|
| Cognitive A skills   | 594 | 33     | 51  | 2      | 1       |
| Big data skills      | 631 | 13     | 21  | 3      | 1       |
| Cognitive skills     | 18 (194) | 3    | 0   | 0      | 0       |
| Total                | 17600 | 4889  | 8015| 548    | 573     |

Table 3. The number of job offers for selected labor markets in January 2020.

| Skill                 | USA | Canada | UK  | Poland | Ukraine |
|----------------------|-----|--------|-----|--------|---------|
| Cognitive A skills   | 614 | 16     | 40  | 6      | 0       |
| Big data skills      | 602 | 7      | 13  | 1      | 1       |
| Cognitive skills     | 14 (113) | 0    | 0   | 0      | 0       |
The significant difference in the number of offers among the studied countries was noticed (Figure 2). The demand for management accountant positions in the Polish and Ukrainian labor markets was more than 30 times lower than in the United States labor market.

The filtered searches in the indeed.com website yielded 18,398 offers in the United States in November, 17,600 offers in December, and 17,496 offers in January (Table 1, Table A1–A4). It was found that cognitive analytics skills are currently very important for management accountants. Comprehensive cognitive skills were required only in 9–18 positions, and 173 companies were looking for professionals with different concrete cognitive abilities—with cognitive flexibility, cognitive thinking, cognitive skills to synthesize multiple inputs and reach a single optimal solution, and similar. In 3.1% of the total number of offers, companies require from management accountants knowledge of the Cognos system. In December and January, the situation on the labor market was subject to slight fluctuations (Table 2, Table 3, Tables A5–A12). The descriptive statistics are presented in the Appendix A.

However, the comparison of this data should be further considered in terms of labor market statistics (Table 4).

The following data were acquired. According to NationMaster database the United States labor force was 154.9 million. It was ranked at 4th place, that is, 8 times more than Canada and many times more than the other studied countries. The Canadian labor force was made up of 18.59 million people, and the United Kingdom’s 31.45 million. Poland’s labor force comprises 17 million of people, while Ukraine’s labor force comprises 22.06 million. On the other hand, the UK’s labor force per 1000 was 505.05, 1% more than that of the United States, which was 500.77. In Canada, the labor force per 1000 was 544.74, 9% more than in the United States. Poland’s labor force per 1000 was 445.22, and in Ukraine, the labor force per 1000 was 480.92 [93]. In terms of labor force per 1000 analysis, the United States was in the leading position. However, the labor force statistics analysis significantly eliminates the difference in size demand between Canada and the United Kingdom. The results of labor force statistics analysis allow for the elimination of the difference in size demand between Canada, the United Kingdom, and the United States, and gives these countries an advantage. Poland and Ukraine
are in lower positions, but with better results due to a lower rate of labor force and labor force per 1000.

In the next step, the obtained data were filtered, and information about the demand in selected labor markets was analyzed in detail. Additionally, the descriptive statistics were calculated in order to prove the data’s usefulness and to enable further analysis and data comparison for future and deeper research. These statistics are presented in the Appendix A.

In the United States, predominantly, the software experience required included, among other systems: Cognos, SAP, Essbase, Oracle Hyperion, Alteryx and Micro-Strategy Peoplesoft, SQL, Excel, DOMO, Lawson, JD Edwards, QAD, CostPoint, etc.

In Canada, the number of job offers for management accountants was about 3.5 times lower than in the United States in November (Table 1). The total of 5272 offers was filtered. It was found that 38% required big data skills; 36% required cognitive analytics skills; 0% required cognitive skills; 10% required different cognitive abilities. The popularity of Cognos and Tableau software skills requirement was noticed. In December and January, the demand for big data skills and cognitive skills dropped dramatically (Tables 2 and 3).

The software currently required for management accountants in Canada included, among others: AS 400, Cognos, Epicor, MS SSAS, SSRS, MS Power BI, QlikView, Tableau, PMP, PeopleSoft, SAP, Oracle Hyperion, NetSuite, Workday, Microsoft Dynamics, Adaptive Insights, etc.

In the United Kingdom, the total number of offers was about 9,000 in November, with a subsequent decrease in the following months (Table 1). It was found that 57% of offers required Cognos experience in November; 3% required with cognitive abilities; 0% required cognitive skills; 60% required with big data skills.

The software experience required in the United Kingdom most often concerned the following systems: Essbase, Cognos, Oracle Hyperion, Anaplan, Spotfire, Microsoft Power BI, Sage, eFinancials, Excel, SAP Hana, Vector, Wims, Capex, Caseware, Lawson, JD Edwards, SAS software. Additionally, some companies were looking for experienced managers with knowledge of VBA, Python, SQL, and R.

A total of 563 offers were filtered in Poland in November, 548 in December, and 518 in January (Table 1–3.) It was found that 3% of offers required Cognos experience; none required cognitive skills; 4% required big data skills.

The software experience required was related to the following systems: SAP, Excel, Oracle, Sage. Additionally: Power Query, Power BI, SQL. In Poland, specialists with Tableau software experience were looked for more often than with Cognos. No job posts with cognitive abilities requirements were found.

In order to analyze the demand in Ukraine, the rabota.ua job searching portal was also checked, because of its greater popularity when compared to indeed.com. Very few companies were looking for management accountants with big data skills and cognitive analytic skills (from 1 to 3% of offers depending on the month), and no offers mentioned cognitive abilities.

In Ukraine, 1C was the preferred software (354 offers in November). The significant popularity of MS Excel was also noticed. It was also found several job posts with SAP, Oracle, and Cognos experience requirements, but no offers mentioned Tableau experience. Sometimes, companies (for example, Deloitte) were looking for management accountants only with BI, MySQL, or R skills.

4. Results

It was found that the situation in different European labor markets varied significantly. Generally, the research revealed differences in cognitive analytics skills, big data skills, and cognitive skills demand between the United States and the other studied countries. Presently, the number of job offers with BD skills and cognitive analytics skills requirements are higher in the United States. The smallest number of offers with skills requirements was noticed in Poland and similarly in Ukraine. In the United Kingdom, the number of these offers was often as high as that of the abovementioned countries (Figures 3–5).
The highest popularity of cognitive abilities was noticed in the United States’ labor market, and it was about 3.5%. In the United Kingdom, the United States, and Canada, accounting managers are generally expected to have more advanced IT skills. In Ukraine and Poland, these skills are currently not so required.

20–30% of UK companies require management accountants to be familiar with ERP systems. In Poland, about 30% of companies require SAP knowledge or experience; 40% require advanced Excel knowledge; 24% require a combination of ERP and Excel; 2% require Oracle experience; and 0.5% require Sage experience.
In Ukraine, the low demand for cognitive analytics and big data skills for management accountants was noticed. On the other hand, the traditional analytic skills requirements were high. The most popular software required in Ukraine was 1C (with a deviation from 60 to 70\% of total job posts) and Excel (with a deviation from 20 to 25\%, in SAP of about 5\%, and in Oracle of about 1\%). The most popular IT tool for managing a large amount of data in Ukraine was Microsoft Excel. Several companies were looking for management accountants specialized in soft programming skills: SQL, Python, and R.

Additionally, the decision to check the demand for Cognos software skills among countries was due to the fact that, according to the ranking on Cognitive Analytics Solutions Quadrant presented at the 360 quadrants website, this system is in the first place (retrieved 05.01.2020) [94]. It was found that IBM Cognos is currently the most popular software in the U.S.A. 3.3\% of U.S.A companies were looking for management accountants with experience in using this software (Figure 6).

![IBM Cognos](image)

**Figure 6.** The percentage of job offers for management accountants requiring Cognos software skills in November 2019–January 2020 in relation to the total number of offers.

5. Discussion

Summarizing the results obtained from the literature study and labor market research, it was concluded that the main technologies that have an impact on managerial accounting development are: big data technologies, cloud computing, cognitive computing, ERP systems, payment platforms, e-commerce platforms, Business Intelligence technologies. These technologies create new IT trends toward cognitive managerial accounting.

The research also revealed that the additional competencies needed for management accountants are, among others: data management and Information Management skills, Change Management skills, Quality Management skills, strong IT and systems knowledge, Supply Chain Management skills, Program Management skills, Project Management skills, IT system implementation skills, and Business Process Management skills. So, the experts’ opinion [43,89,92,95] on the core competencies of future management accountants were confirmed. Additionally, we observed the increasing popularity of the cognitive ability “to understand the big picture” in the United Kingdom, Canada, and the United States.

On the basis of the literature study from Section 2 (especially regarding [76,87,92,96,97]) and the labor market analysis from Section 3 (on the basis of the appearance frequency in job posts), the current model of management accountants’ core skills and abilities was created (Figure 7).

The model considers two methodological approaches: the theoretical and the practical approach. In this model, one set of competencies is defined for a broad range of similar job positions corresponding to management accounting. The skills model of management accountant positions is
built around 3 main groups: technical (specific skills), cognitive skills, and social and behavior skills. Due to the generic character of the skills considered, the model was qualified as a generic skills model.

The procedure of model creation was constructed in line with the methodological requirements presented in the literature on the subject [98–104].

The following methodological approach was used in order to build the current management accountant skills model (Figure 7). 

![Figure 7. The framework for skills model creation.](image)

The first stage was the target group identification. In this case, the target group consisted of management accountants and similar job positions. The second stage was the purpose and range establishing. The main purpose was to create a current model taking into consideration cognitive technologies and cognitive abilities and clearly highlighting them. The third stage was the selection of data collection methods. Among different methods, such as literature reviews, surveys, focus groups, interviews, etc., the literature review and labor market survey were selected. First, the literature study was conducted. The next stage was the model structure creation. Based on the literature study, the main structure of the model was created, including building the skills hierarchy by synthesizing them into the three main groups and providing a description with the relevant competencies for each group.

To evaluate and extend the results of the literature review, the labor market research was conducted. The next stage was the model validation through a labor market research and the model complementation with additional abilities corresponding with the main groups. At this stage, the frequency of the occurrence of abilities in job posts was analyzed. The last stage was the model revision and correction. The abilities that frequently appear in job posts and were not identified as a result of a literature study were added to the model. The abilities that do not appear in labor market analysis were excluded from the model. The model revision should be continuous. The enterprises should develop the framework checking current demand and market tendencies.

Based on the literature, a total of 30 competencies were derived. Various authors underline the key competencies required. The model contains three skill groups (Figure 8):

1. Technical skills (specific skills):
   - Accounting skills: depend on job position.
   - Management skills: Business Process Management [43,92], Change management [43,92,97], Supply Chain Management [43,97], Quality Management [43,97], Project Management [43,92], Data and Information management [92,97], Knowledge Management [92,97], etc.
   - IT skills: cognitive Analytics [18,20–22,44,58,59,62–64], Artificial Intelligence [18–22,44,58,59,62–64,97], Integrated Information systems [39,43,92,97], Cloud Computing [95,97], Big Data [20,25–27,39,97], Business Intelligence [39,43,97], programming [97], data mining [43,92], data reporting and visualization [19,37–41,43,97], e-commerce [92], e-marketing [92], system implementation skills [43,97], etc.

2. Cognitive skills: flexibility [76], analytical skills [43,58,76,92,97], synthesis skills [76,97], ability “to see the big picture” (labor market research), judgment abilities (evaluation) [76,84,86,97], prediction abilities [76,97], reflection abilities [3,89,90].
3. Social and behavioral skills: Leading skills [92,97], Team working [92,97], Communication skills [92], Organizational skills [97].

Figure 8. The model of current management accountants core skills.

The research has several limitations. First, it was hard to identify and exclude repeated job posts. The second limitation was that the study investigates only the “conscious demand”. That means that the research was based only on the job posts which contain the concrete definition of technologies like “big data”, “cognitive analytics”, and more soft definitions like “large data sets” analysis or “large amounts of data”. It could be presumed that some enterprises are also looking for management accountants with advanced cognitive analytics skills. However, they do not specify it sufficiently in job posts.

6. Conclusions

The era of cognitive technologies is approaching. However, many doubts related to the future of the accountant profession have appeared. Management accountants need to stay up to date with technological advances and accounting software.
Currently, cognitive technologies are already changing the labor markets of the surveyed countries, serving as an essential addition to the accounting profession. They are a tool for deep data analysis and decision making. Routine work is still carried out using ERP and financial systems.

Cognitive Analytics skills are currently required for managerial accountant positions, especially in the United States’ labor market, where cognitive technologies are used by many companies. The Cognitive Analytics skills are currently predominantly required in U.S.A. companies or international large companies. The number of positions where knowledge of cognitive technologies is required in Polish and Ukrainian markets is negligible. Small and medium enterprises still implement the concept of traditional or cloud accounting with Microsoft Excel analytics. In international companies, additionally, geographical analysis skills and knowledge of multidimensional visualization tools are required. The demand for additional advanced competencies in the field of data, information, and knowledge management for managerial positions in accounting was also proved and noticed.

To wrap up, most posted jobs were targeting highly qualified specialists. Therefore, high education institutions need to modernize and modify their programs in order to meet the labor market expectations. Moreover, future management accountants should not only be technically strong, but also have high cognitive abilities in order to support strategic decision-making and drive the business forward through increasingly large data sets.

The created skills model considers the management accountant profession in terms of smart sustainable business management. It takes into consideration the cognitive abilities and technical skills which are necessary for using cognitive information technologies. The proposed model had the advantage of being based on job offers, which clearly define competencies required of management accountants, associated with new technology skills and cognitive abilities. This enables the calculation of the “aware” demand.

There is a wide range of practical applications for the developed skills model. First, it can serve as the basis for developing a competency model in enterprises. In addition, the model can be used as a starting point for the development of new and more sustainable curricula at universities, as well as the creation of new training courses, including IT courses for various educational organizations. This model also indicates the directions of software development for management accounting users.

In the future, the number of analyzed countries should be enlarged. Such a comparison could reveal the geographical spread directions of cognitive technology development in the sphere of managerial accounting. It may also help high education institutions to prepare educational programs for the next decade.

**Funding:** “This research received no external funding”

**Conflicts of Interest:** “The authors declare no conflict of interest”

**Appendix A**

| Table A1. Descriptive statistics to Table 1. |
|-------------------------------------------|
| Value | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|-------|----------|----------|----------|----------|----------|
| Mean  | 466      | 28       | 40       | 2.33     | 1        |
| Standard Deviation | 256.8 | 15.62 | 32.08 | 2.08 | 1.73 |
| Minimum | 173   | 10       | 3        | 0        | 0        |
| Maximum | 652   | 38       | 60       | 4        | 3        |
| Range  | 479     | 28       | 57       | 4        | 3        |
| Median | 573     | 36       | 57       | 3        | 0        |
| Geometric Mean | 401.31 | 23.92 | 21.73 | 0 | 0 |
| Harmonic Mean | 331.15 | 19.47 | 8.16 | 0 | 0 |
| Variance | 65947 | 244 | 1029 | 4.33 | 3 |
| Kurtosis | 0 | 0 | 0 | 0 | 0 |
| Skewness | -1.55 | -1.7 | -1.72 | -1.29 | 1.73 |
| First Quartile | 373 | 23 | 30 | 1.5 | 0 |
| Third Quartile | 612.5 | 37 | 58.5 | 3.5 | 1.5 |
| Interquartile Range | 239.5 | 14 | 28.5 | 2 | 1.5 |
| Sum | 1398 | 84 | 120 | 7 | 3 |
Table A2. Pearson correlation (see Table 1).

| Column number | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|---------------|----------|----------|----------|----------|----------|
| Column 1      | 1        | 0.6639   | 0.6628   | 0.6641   | 0.4182   |
| Column 2      | 0.6639   | 1        | 0.6666   | 0.6561   | 0.3696   |
| Column 3      | 0.6628   | 0.6666   | 1        | 0.6539   | 0.36     |
| Column 4      | 0.6641   | 0.6561   | 0.6539   | 1        | 0.4623   |
| Column 5      | 0.4182   | 0.3696   | 0.36     | 0.4623   | 1        |

Table A3. Spearman correlation (see Table 1).

| Column number | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|---------------|----------|----------|----------|----------|----------|
| Column 1      | 1        | 0.6667   | 0.6667   | 0.6667   | 0.5774   |
| Column 2      | 0.6667   | 1        | 0.6667   | 0.6667   | 0.5774   |
| Column 3      | 0.6667   | 0.6667   | 1        | 0.6667   | 0.5774   |
| Column 4      | 0.6667   | 0.6667   | 0.6667   | 1        | 0.5774   |
| Column 5      | 0.5774   | 0.5774   | 0.5774   | 0.5774   | 1        |

Table A4. Covariance (see Table 1).

| Column number | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|---------------|----------|----------|----------|----------|----------|
| Column 1      | 43964,6719 | 2663,333 | 5460   | 355   | 186   |
| Column 2      | 2663,333 | 162,6667 | 334   | 21,3333 | 10 |
| Column 3      | 5460   | 334   | 686   | 43,6667 | 20 |
| Column 4      | 355   | 21,3333 | 43,6667 | 2,8889 | 1,6667 |
| Column 5      | 186   | 10   | 20   | 1,6667 | 2 |

Table A5. Descriptive statistics (see Table 2).

| Value           | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|-----------------|----------|----------|----------|----------|----------|
| Mean            | 473      | 16.33    | 24       | 1.67     | 0.67     |
| Standard Deviation | 242,33   | 15.28    | 25.63    | 1.53     | 0.58     |
| Minimum         | 194      | 3        | 0        | 0        | 0        |
| Maximum         | 631      | 33       | 51       | 3        | 1        |
| Range           | 437      | 30       | 51       | 3        | 1        |
| Median          | 594      | 13       | 21       | 2        | 1        |
| Geometric Mean  | 417,39   | 10,88    | 0        | 0        | 0        |
| Harmonic Mean   | 356,17   | 6.81     | 0        | 0        | 0        |
| Variance        | 58723    | 233,33   | 657      | 2.33     | 0.33     |
| Kurtosis        | -1.69    | 0.94     | 0.52     | -0.94    | -1.73    |
| Skewness        | 0        | 0        | 0        | 0        | 0        |
| First Quartile  | 394      | 8        | 10.5     | 1        | 0.5      |
| Third Quartile  | 612,5    | 23       | 36       | 2.5      | 1        |
| Interquartile Range | 218,5   | 15       | 25.5     | 1.5      | 0.5      |
| Sum             | 1419     | 49       | 72       | 5        | 2        |

Table A6. Pearson correlation (see Table 2).

| Column number | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|---------------|----------|----------|----------|----------|----------|
| Column 1      | 1        | 0.4692   | 0.5092   | 0.6448   | 0.6647   |
| Column 2      | 0.4692   | 1        | 0.6641   | 0.3333   | 0.504    |
| Column 3      | 0.5092   | 0.6641   | 1        | 0.3831   | 0.5406   |
| Column 4      | 0.6448   | 0.3333   | 0.3831   | 1        | 0.6299   |
| Column 5      | 0.6647   | 0.504    | 0.5406   | 0.6299   | 1        |

Table A7. Spearman correlation (see Table 2).

| Column number | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|---------------|----------|----------|----------|----------|----------|
| Column 1      | 1        | 0.3333   | 0.3333   | 0.6667   | 0.5774   |
| Column 2      | 0.3333   | 1        | 0.6667   | 0.3333   | 0.5774   |
| Column 3      | 0.3333   | 0.6667   | 1        | 0.3333   | 0.5774   |
| Column 4      | 0.6667   | 0.3333   | 0.3333   | 1        | 0.5774   |
| Column 5      | 0.5774   | 0.5774   | 0.5774   | 0.5774   | 1        |
Table A8. Covariance (see Table 2).

| Column number | Column 1    | Column 2    | Column 3    | Column 4    | Column 5    |
|---------------|-------------|-------------|-------------|-------------|-------------|
| Column 1      | 39,148,6719 | 17,36,667   | 3163        | 238,6667    | 93          |
| Column 2      | 17,36,667   | 155,5556    | 260         | 7,7778      | 4,4444      |
| Column 3      | 3163        | 260         | 438         | 15          | 8           |
| Column 4      | 238,6667    | 7,7778      | 15          | 1,5556      | 0,5556      |
| Column 5      | 93          | 4,4444      | 8           | 0,5556      | 0,2222      |

Table A9. Descriptive statistics (see Table 3).

| Value          | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|----------------|----------|----------|----------|----------|----------|
| Mean           | 443      | 7.67     | 17.67    | 2.33     | 0.33     |
| Standard Deviation | 285.85 | 8.02     | 20.4     | 3.21     | 0.58     |
| Minimum        | 113      | 0        | 0        | 0        | 0        |
| Maximum        | 614      | 16       | 40       | 6        | 1        |
| Range          | 501      | 16       | 40       | 6        | 1        |
| Median         | 602      | 7        | 13       | 1        | 0        |
| Geometric Mean | 346.97   | 0        | 0        | 0        | 0        |
| Harmonic Mean  | 427.13   | 0        | 0        | 0        | 0        |
| Variance       | 8171     | 64.33    | 416.33   | 10.33    | 0.33     |
| Kurtosis       | -1.73    | 0.37     | 0.98     | 1.55     | 1.73     |
| Skewness       | 0        | 0        | 0        | 0        | 0        |
| First Quartile | 357.5    | 3.5      | 6.5      | 0.5      | 0        |
| Third Quartile | 608      | 11.5     | 26.5     | 3.5      | 0.5      |
| Interquartile Range | 250.5 | 8        | 20       | 3        | 0.5      |
| Sum            | 1329     | 23       | 53       | 7        | 1        |

Table A10. Pearson correlation (see Table 3).

| Column number | Column 1    | Column 2    | Column 3    | Column 4    | Column 5    |
|---------------|-------------|-------------|-------------|-------------|-------------|
| Column 1      | 1           | 0.5596      | 0.509       | 0.4299      | 0.3211      |
| Column 2      | 0.5596      | 1           | 0.6613      | 0.6378      | -0.048      |
| Column 3      | 0.509       | 0.6613      | 1           | 0.6573      | -0.132      |
| Column 4      | 0.4299      | 0.6378      | 0.6573      | 1           | -0.2395     |
| Column 5      | 0.3211      | -0.048      | -0.132      | -0.2395     | 1           |

Table A11. Spearman correlation (see Table 3).

| Column number | Column 1    | Column 2    | Column 3    | Column 4    | Column 5    |
|---------------|-------------|-------------|-------------|-------------|-------------|
| Column 1      | 1           | 0.6667      | 0.6667      | 0.6667      | 0           |
| Column 2      | 0.6667      | 1           | 0.6667      | 0.6667      | 0           |
| Column 3      | 0.6667      | 0.6667      | 1           | 0.6667      | 0           |
| Column 4      | 0.6667      | 0.6667      | 0.6667      | 1           | 0           |
| Column 5      | 0           | 0           | 0           | 0           | 1           |

Table A12. Covariance (see Table 3).

| Column number | Column 1    | Column 2    | Column 3    | Column 4    | Column 5    |
|---------------|-------------|-------------|-------------|-------------|-------------|
| Column 1      | 54474       | 1283        | 2969        | 395         | 53          |
| Column 2      | 1283        | 42,8889     | 108,2222    | 16,4444     | -0.2222     |
| Column 3      | 2969        | 108,2222    | 277,5555    | 43,1111     | -1,5556     |
| Column 4      | 395         | 16,4444     | 43,1111     | 6,8889      | -0.4444     |
| Column 5      | 53          | -0.2222     | -1,5556     | -0.4444     | 0.2222      |

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