ACTUARIES and DATA SCIENCE 2020 SURVEY SUMMARY

Acknowledgements

This report was prepared by the Big Data Working Group (BDWG) of the International Actuarial Association (IAA).

The IAA is the worldwide association of professional actuarial associations, with several special interest sections and working groups for individual actuaries. The IAA exists to encourage the development of a global profession, acknowledged as technically competent and professionally reliable, which will contribute to the public interest being served.

The role of the BDWG is to identify what technical work actuaries are already doing or could do with big data, create a forum for them to share knowledge and expertise, encourage communication and sharing of information on big data related topics, identify big data experts with whom the IAA can work to develop this practice area, and encourage and facilitate the IAA's involvement in big data forums where the IAA and its members can both learn from and add value to other participants.

This is a report on the "Actuaries in Data Science Survey 2020" that was conducted by the BDWG. The report was primarily an effort of a subgroup of the BDWG including Yair Babad, Mahidhara Davangere, Yashica Nagpaul, and Ryutaro Yamada. It was reviewed and approved by the BDWG for distribution within the IAA.

The intent of this report is to present the views of those responding to the survey. Thus, the views expressed in this report are not necessarily the views of the IAA nor those of the entire BDWG.

We would like to express our gratitude to all those who responded to the survey.

Executive summary

The Big Data Working Group (BDWG) of the International Actuarial Association (IAA) conceived in mid-2019 a fact-finding survey of actuaries world-wide to determine their familiarity and use of data science tools and techniques. The survey was conducted via the IAA's *Weekly News Brief* (March 11, 2020). It reached about 1,000 people, out of which 123 responded (a response rate of approximately 12%).

Analysis of the results demonstrates that actuaries are increasingly interested in data science and its incorporation into their work and activities. The results from the survey, however, seem to indicate that the road to a closer coherence between data science and actuarial science is likely still a long one.

The BDWG used the terms "data science" and "data analytics" in the survey questions recognizing that actuaries frequently use these terms interchangeably with predictive analytics. The BDWG expects that feedback to the survey questions on "data analytics" reflects work in the use of big data, machine learning, statistical analysis, and mathematical or computer-based models for improved insight and decision-making.

Highlights from the survey results[1] include:

Data Science related findings

- Insights, value, risks management, and efficiency are reported to be the top benefits of data science initiatives. [question 21, section 3.2.1]
- More than 50% responded that data analytics are sometimes used for strategic decisions, and 30% informed that they are mostly or always being used. [question 18, section 3.1.3]
- Most respondents believe that data analytics will be heavily used for strategic decisions in the next three years. Most respondents believe that the management – at all levels, even those not using it strategically – will be those who adopt or push data analytics. [questions 19-20, section 3.1.3]
- Most reported that responsibility for analytical work was spread across the organization in an unstructured manner. [question 14, section 3.1.1]
- There was a wide range of responses with respect to the extent of integration of IT in activities related to data science; few reported full integration of the IT function. [questions 15-17, section 3.1.2]
- Many different methods are used to gain knowledge about data science including conference and seminars and on-line reference material, which had the highest response rates, as well as books, learning from non-actuaries and actuaries, and actuarial associations. [question 13, section 4.1]

[1] At the end of each highlight, we provided a reference to the survey question and to the report section where this highlight is discussed.

- Respondents reported that the barriers to adoption were (in decreasing order): shortage of skilled staff, lack of appropriate infrastructure, insufficient data, segregation of data, and lack of perceived need by management. [question 22, section 3.2.2]
- Respondents reported that the major software tools used for predictive analytics include Excel, R, Python, and SAS. [question 23, section 4.2.1]
- Traditional actuarial methods, such as regression techniques, general linear models, and data visualization, continue to be used extensively. These tools were reported most frequently by users in the 30-49 age group. [question 24, section 4.2.2]

Demographic and professional profile of respondents

- 40% of the respondents were from Asia, closely followed by Europe (34%), with the Americas far behind (14%). Respondents from Asia and Europe present similar levels of predictive analytics knowledge and use in all the surveyed areas. [section 2.1]
- Most respondents were at least somewhat familiar with data science: 15% declared themselves as regular users, 21% as users, and 24% tried it. One-third had no experience. Two-thirds of these respondents were in the 40+ age group and in middle and senior management positions. We expect that many respondents in the older age groups and more senior management roles developed their actuarial expertise before the emergence of predictive analytics. [question 11, section 2.2]
- About 90% of respondents were qualified actuaries, 75% had more than 10 years of work experience, and 60% were managers or executives. More than 50% with 25+ experience years reported having no data science experience. We expect this high proportion of the more experienced actuaries is likely due to the relatively recent emergence of data science. [question 6, section 2]
- The majority (189 responses, including multiple responses) were in traditional actuarial roles, 112 respondents were in business intelligence, research, and business development, and 68 were in management and regulatory reporting. [questions 9-10, section 2.3]

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1. *Introduction*

The Big Data Working Group (BDWG) of the International Actuarial Association (IAA) conceived in mid-2019 the idea of a fact-finding survey of actuaries world-wide to determine their familiarity and use of data science. Specifically, the objectives were to better understand attitudes towards the data science field, find out the extent of use of data science (including artificial intelligence and other big data analytics techniques), and to identify the barriers to entry and the rewards associated with integrating advanced analytics into more actuarial work.

The survey, the first by the BDWG, was conducted via the IAA's *Weekly News Brief* (March 11, 2020) and was shared with anyone connected with the IAA that had consented to receiving such e-mails from the IAA. This list included all members of the IAA Committees, Working Groups, and Sections. In addition, some participants promulgated the survey within relevant groups outside the IAA to get greater coverage. The survey reached about 1,000 people, out of which 123 responded, a response rate of approximately 12%. The survey questions are included in the Appendix.

In speaking about data science, S.R. Coleman notes,

> actuaries and actuarial science should be recognized as the early practitioners and building blocks of modern data science … (since) the 1800's … actuaries have pioneered the use of data, math, statistics, economics, and are now increasingly using computing, automation and machines to predict the future and manage risk … data science and actuarial science (are) necessary bedfellows for the future.[2]

The Institute and Faculty of Actuaries notes that data science

> uses scientific methods like statistics, data mining, and data analytics, with emergent tech like artificial intelligence and machine learning, processes, algorithms, and other software tools, to derive insights and knowledge from structured and unstructured data sets. Actuarial science categorizes interrelated fields, such as computer science, economics, finance, mathematics, probability theory, and statistics to assess risk, primarily in the banking, financial services, insurance sectors. Both sciences have much in common, with the primary commonality between them is their respective appetites for data, and practitioner skills are increasingly transferable between the two fields.[3]

[2] "Actuary 2050: data science and actuarial science as one?", S.R. Coleman, 2/2019, https://medium.com/infonation-monthly/actuary-2050-data-science-and-actuarial-science-as-one-77b89185bae9.

[3] "What is data science: an actuarial viewpoint", IFoA, 2014-2020, https://www.actuaries.org.uk/learn-and-develop/lifelong-learning/what-data-science-actuarial-viewpoint.

On March 2018, PWC published a summary of observations based on their service experience and a survey of leading carriers on what insurers' analytics function will look like in the future.[4] In their opinion "a successful integration of actuaries and data scientists will be critical to enhancing the value of analytics." PwC's perspective on the role of actuaries and data scientists today compared to what is expected by 2030 is presented in chart 1.

Chart 1 – Actuaries and Data Science Today vs. 2030

In 2018, the American Academy of Actuaries (the Academy) published a report on big data and the role of actuary, wherein they presented current and emerging big data practices and discussed the related regulatory and professionalism considerations.[5] The Academy described InsurTech, the innovative use of technology to transform the insurance buying, underwriting, and in-force management by replacing traditional constructs with technology-driven systems that use predictive analytics and are often independent of traditional approaches.

A year later, the Society of Actuaries (SOA) presented a monograph on the actuary of the future in today's data-driven world. [6] Much of the document was concerned with the use of non-traditional data, i.e., data that has not traditionally been used by insurance actuaries, both in traditional ways and in non-traditional ways such as wellness programs, value-based payment models, and usage-based insurance. The SOA considered – among others – demographic, financial, government, climate, medical, and telematics data. The monograph also discussed the new skillsets, roles, and tools that will be expected from the actuary of the future.

The analysis of the survey results, as given in the following sections, demonstrates that actuaries and insurance companies are increasingly interested in data science and how such is being incorporated into their work and activities. At the same time, it seems that the road to a closer coherence between data science and actuarial sciences may still be long.

2. *Demographics, experience, and data science familiarity*

We start with a summary of the demographics and experience of the survey respondents. This provides context to the responses related to data analytics as detailed in this and the following chapters. It will also enable the readers to better relate the demographic and professional experience of the respondents with their use of data science and advanced analytics. Further,

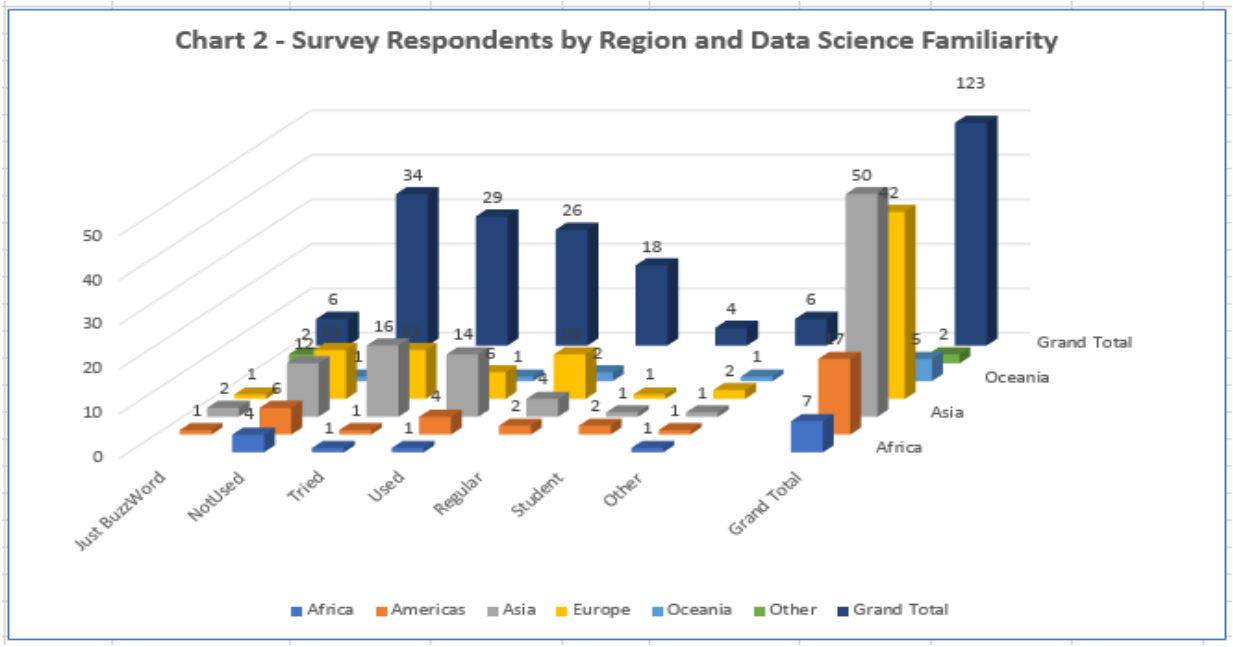
[4] "How do actuarial and data science skills converge at life insurance?", PWC, 3/2018, https://www.pwc.com/us/en/insurance/publications/assets/pwc-life-actuaries-data-scientists-role.pdf.

[5] "Big Data and the Role of the Actuary", Big Data Task Force, American Academy of Actuaries, 6/2018, https://www.actuary.org/sites/default/files/files/publications/BigDataAndTheRoleOfTheActuary.pdf.

[6] "Big Data and the Future Actuary", L. Schwartz and M. Douglas, the Society of Actuaries, 4/2019, https://www.soa.org/globalassets/assets/files/resources/research-report/2019/big-data-future-actuary.pdf.

to link the responses with the actual text of the survey's questions, we list at each section's heading the question numbers of the questions summarized in the section.

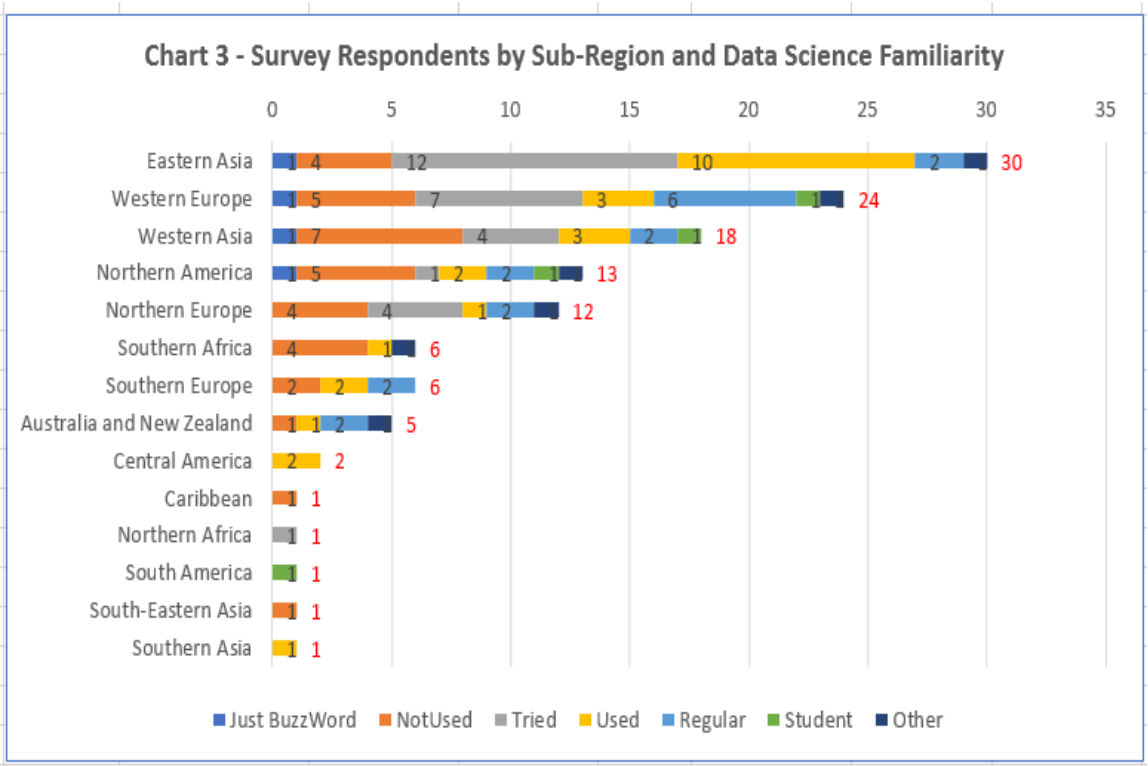
The survey was completed by 123[7] people from all over the globe as shown in chart 2. The majority were from Asia (50), closely followed by Europe (42). The Americas were far behind (17)[8], with few from the other continents (Africa and Oceania), and two who did not report their origin. As to familiarity with data science, out of the 123 respondents, most were at least somewhat familiar with data science: 18 (15%) declared themselves as regular users, 26 (21%) as users, and 29 (24%) tried data science and its techniques. Still, 40 (33%) respondents were without any data science experience. Based on respondents, actuaries in Asia and Europe generally presented similar levels of knowledge and use of data science in all the surveyed areas.



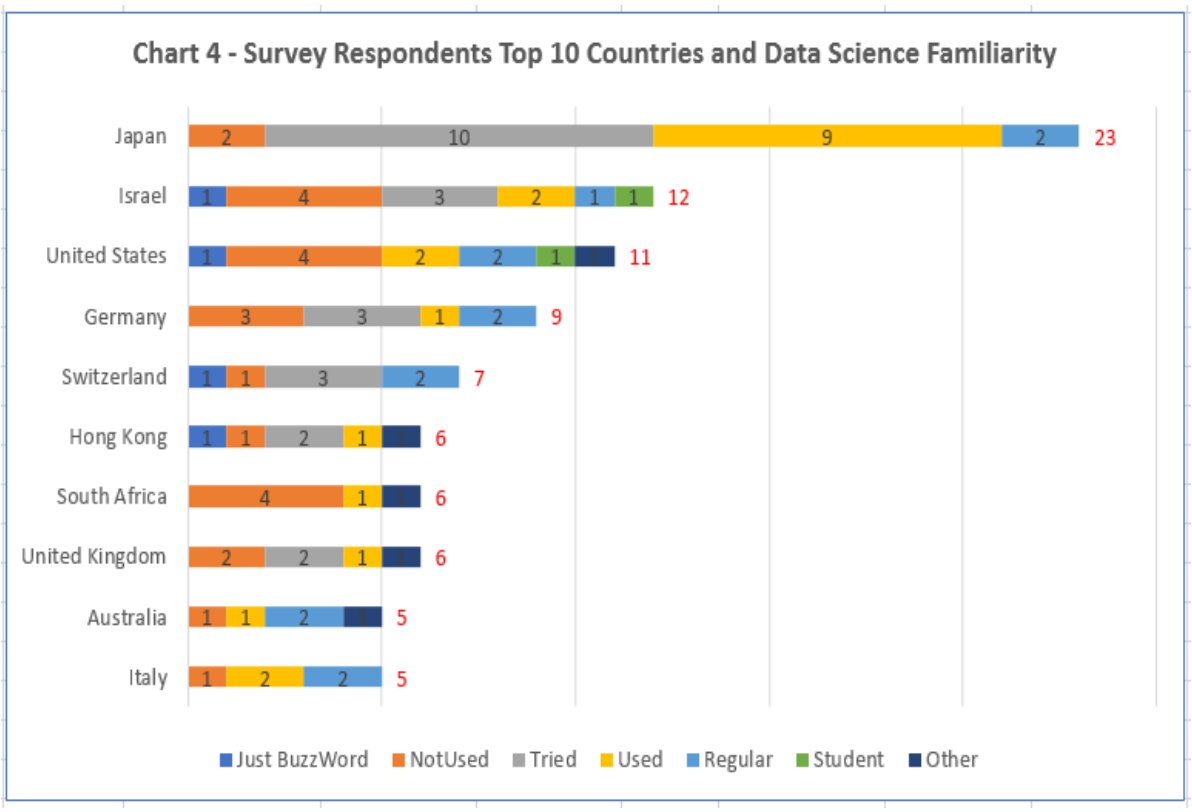
[7] To ease viewing the charts in this report, we visually "scaled down" in many charts bars that were "too high" (and thus would have dampened all other bars, making the study of the charts hard). However, the values on top of each bar are the correct values from the survey. Some of the charts in this report may look "busy" to some readers. Those readers are requested to contact Mahidhara Davangere at mahidhara@pramartha.com, and will be sent the anonymous Excel response to the survey, from which they can determine the information they are interested in.

[8] Out of these 17, 11 were from the U.S. Similarly, out of the 24 from Western Europe (as shown in Chart 3), only six were from the U.K. This low level of response from these strongholds of the actuarial profession, may presumably be due to the availability in these countries of very strong actuarial associations with local very active sections. It may also be due to the limitations of the IAA mailing list which served this study.

2.1 Respondents country & region vs. their data science familiarity (q. 2-3, 11)



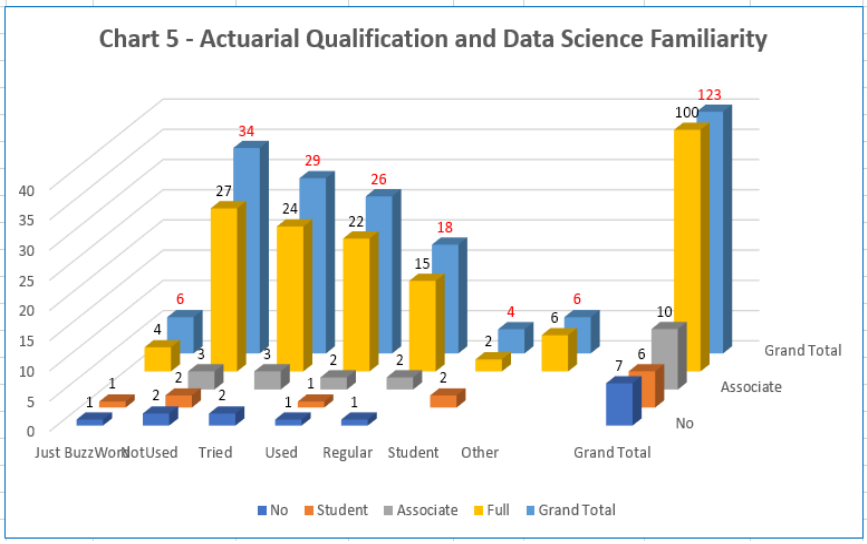
The respondents were from 32 countries in 14 geographical sub-regions as shown in chart 3. Eastern Asia was dominant with 30 or 24% respondents of which two were regular users, ten who used, and 12 who tried data science in the past. Eastern Asia was followed by Western Europe (24 or 20%) respondents and Western Asia (18 or 15%). As noted previously, the response rates were quite low from North America (13 or 11%) and Northern Europe (12 or 10%). We recognize that the lower percentages for Europe and North America are not representative of the familiarity with and use of data science in these regions but simply represent the lower number of respondents to this survey. In this chapter, we use a sub-regional breakdown (in contrast to what we do in the following chapters, due to insufficient detail) to highlight and emphasize that the interest in data science as indicated solely by the respondents to this survey exists throughout the world, but it is not uniformly spread – not even within regions and continents.

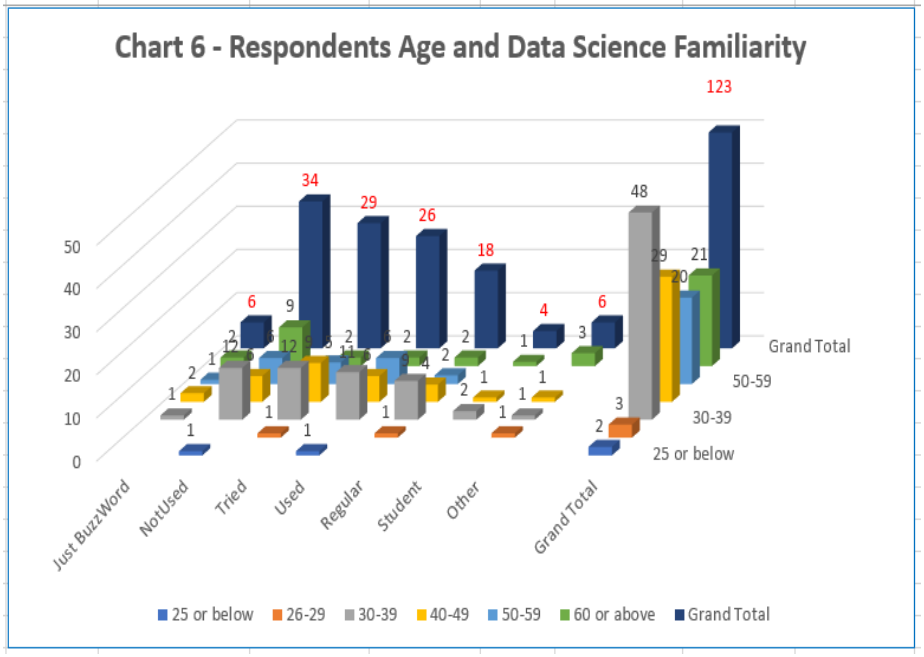


As seen on chart 4, Japan had the largest number of respondents (23 or 19%), followed by Israel (12 or 10%), United States (11 or 9%), Germany (9 or 7%), and Switzerland (7 or 6%). Note that Israel, who follows the United Kingdom actuarial procedures and is a high-tech bastion, effectively should be included in Europe (even though we allocated it in this report to its geographical location in Asia).

2.2 Age and experience vs. data science familiarity (q. 5, 8, 11)

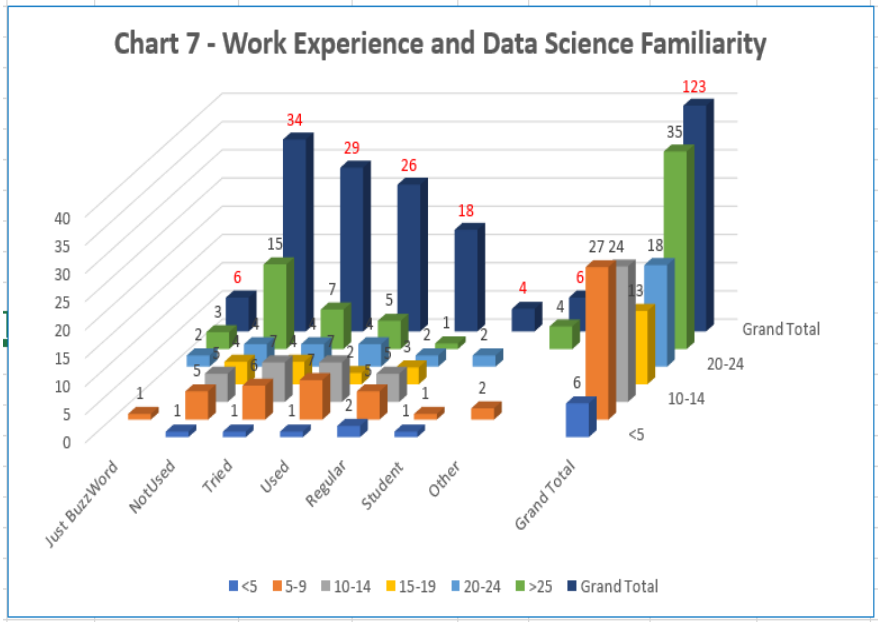
Most of the respondents (100), as shown on chart 5, were fully qualified actuaries, 10 were qualified associate actuaries, 6 were students, and 7 were not actuaries. This distribution of respondents is not surprising given the profile of actuaries involved with the IAA, which was the primary target for the survey.



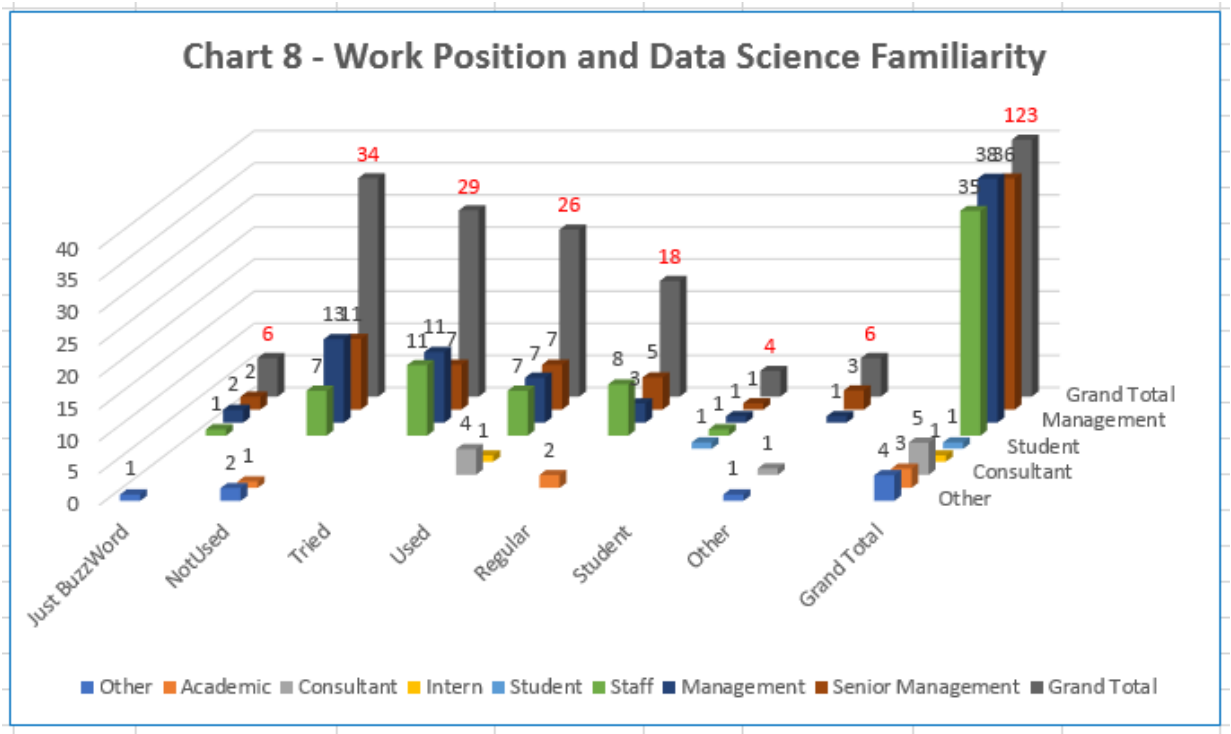


About 60% (77 respondents) were between ages 30 and 49, with the largest group being the 30- 39 years old of which 42% (20 out of 48) reported data science familiarity as either regular or used data science. Similarly, one-third (10 out of 29) of the 40-49 years old have similar data science experience.

In terms of years of work experience, as seen on chart 7, the largest group have over 25 years' experience with 35 respondents, followed by the 5-9 years (27). However, considering the recent emergence of the data science discipline, it is not surprising that more than 50% of over 25 years have no data science experience in contrast to the two-thirds (18) of 5-9 years respondents with some level of data science experience (i.e. tried, used or regular).



2.3 Position, practice area, participants function vs. data science (q. 7, 9-10, 11)

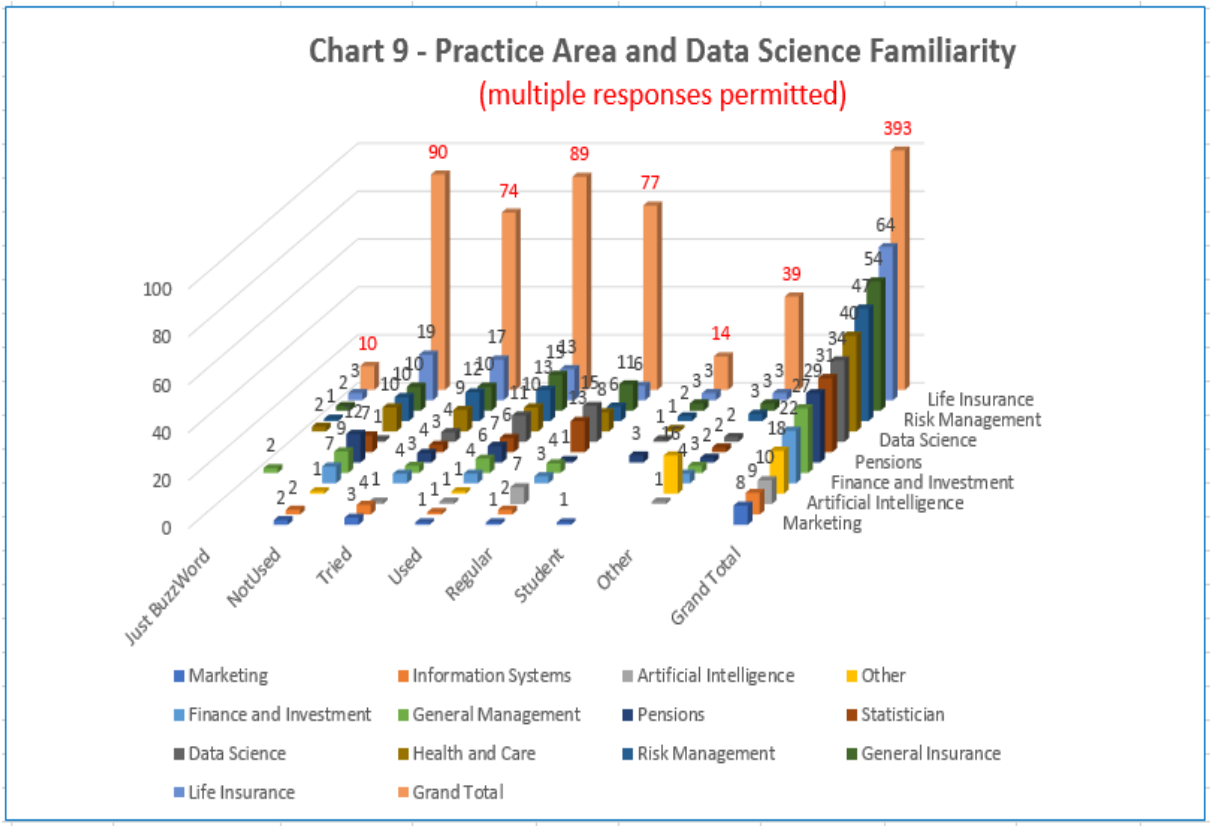


Per chart 8, the majority of respondents were managers, with 29% being senior management and 31% management. Staff members were nearly one-third (29%). As expected, staff use data science more regularly (26 out of 36, or 72%) than the managers (40 out of 74, or 54%). Few respondents (13) were consultants, academics, interns, or others.

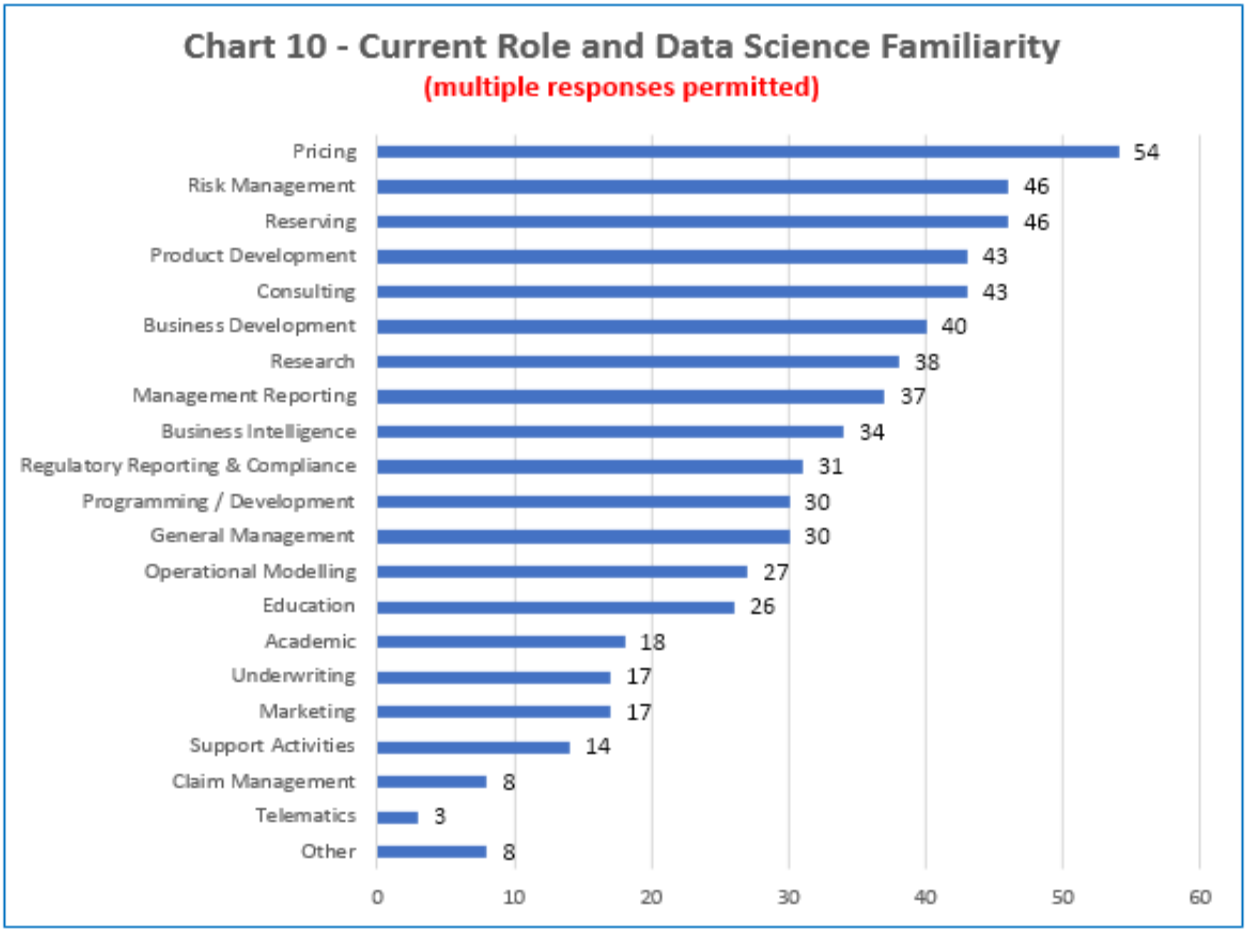
Many of the respondents, shown on chart 9, indicated that they practice in multiple areas. Close to 400 responses were given to the practice area question, with about three responses on average per participant. Out of these 393 responses:

- 205 responses were in various insurance activities, with an average of about two areas per participant;
- 64 are involved in life insurance,
- 54 in general insurance,
- 47 in risk management, and
- 40 in healthcare.

The other reported practice areas were non-traditional areas.



As chart 10 demonstrates, the majority of responses (189, including multiple responses) were in traditional actuarial roles, such as pricing, risk management, reserving, and product development. 112 respondents were involved in business intelligence, research, and business development, while 68 were in management and regulatory reporting, and 43 acted in consulting roles (often within their own organizations). Few respondents specialized in underwriting, claim management, or telematics; based on experience of BDWG members, these results would likely show significant differences if responses from North America and the U.K. had been included as advanced analytics are being used by many actuaries for these three areas in particular.



2.4 Limitations

The analysis of any survey is limited by the questions asked and the number of respondents. The BDWG recognizes that data science is of growing importance to actuaries individually, to the actuarial professional organizations around the world, and to employers of actuaries. While significant effort was made to ensure wide distribution and participation of this survey, there was, in the end, very limited participation by North American and U.K. actuaries. Knowing the growing use of data science and the activities of actuarial organizations in these regions, users of this report should consider the potential limitations given the absence of a significant number of respondents.

Furthermore, the high response rates from Japan and Israel may be related to the distribution of the survey to actuaries in these countries by leaders in the Institute of Actuaries of Japan and the Israel Association of Actuaries, respectively, who are also active members of the IAA BDWG.

Similarly, participants in the IAA (to whom the survey was distributed) tend to be older and thus may have acquired their experience as actuaries before educational material about data science was on the education syllabus and before the use of data science was so prevalent in actuarial work. This may influence the responses to the BDWG's survey, and thus the survey's findings reported herein may not be representative of the entire profession's viewpoint.

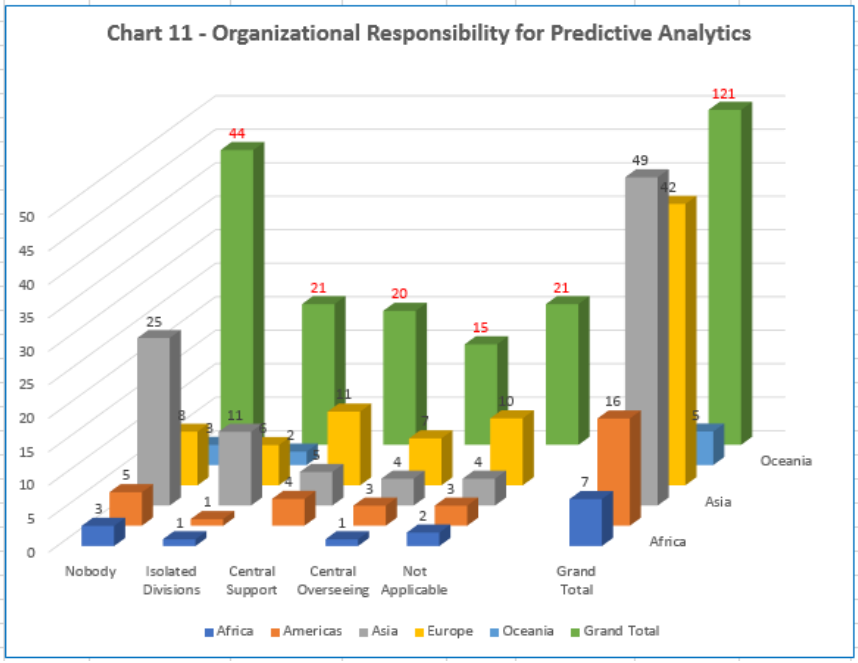
3. *The use of data science in organizations*

This chapter summarizes the application of data science to the organizational environment and the professional activities performed by the survey's respondents. The responses also highlight the acceptance of analytics by their employers and the allocation of responsibility for the use of analytics within these organizations. Finally, the respondents also identified barriers to entry and use as well as benefits associated with the use of these techniques.

3.1 Data science and the organization (q. 14-20)

3.1.1 Responsibility for analytical areas (q. 14)

Overall, as seen in chart 11, most respondents (65 out of the 100 who did not respond with Not Applicable) indicated that the responsibility for analytical work did not reside with any one team or unit but was spread across the organization in an unstructured manner. European respondents, however, noted a more structured approach in place for analytical work with either a central support team or central oversight function. This is possibly a reflection of the maturity of European markets.



3.1.2 Level of information technology (IT) support (q. 15-17)

The level of support provided by the IT function to the organization's analytics, data science, and big data activities varied by the type of the IT activities involved. We present, for three type of IT activities, the responses organized by region (charts 12R, 13R and 14R). We also present the responses according to the positions of the respondents (charts 12P, 13P and 14P).

Out of the 123 respondents, 44 indicated that they received minimal or no support for extraction and provision of data, 54 reported minimal or no support for networking and data acquisition; and with regards to communication with the actuarial staff, 54 reported minimal or no support. The responses from senior management were higher than those of management and staff with respect to receiving some support from the IT function. In all cases, full integration was low, which were less than 10 responses. Similar results were evident when the responses were broken down by region, where Asia and Europe reported somewhat more support than the other regions.

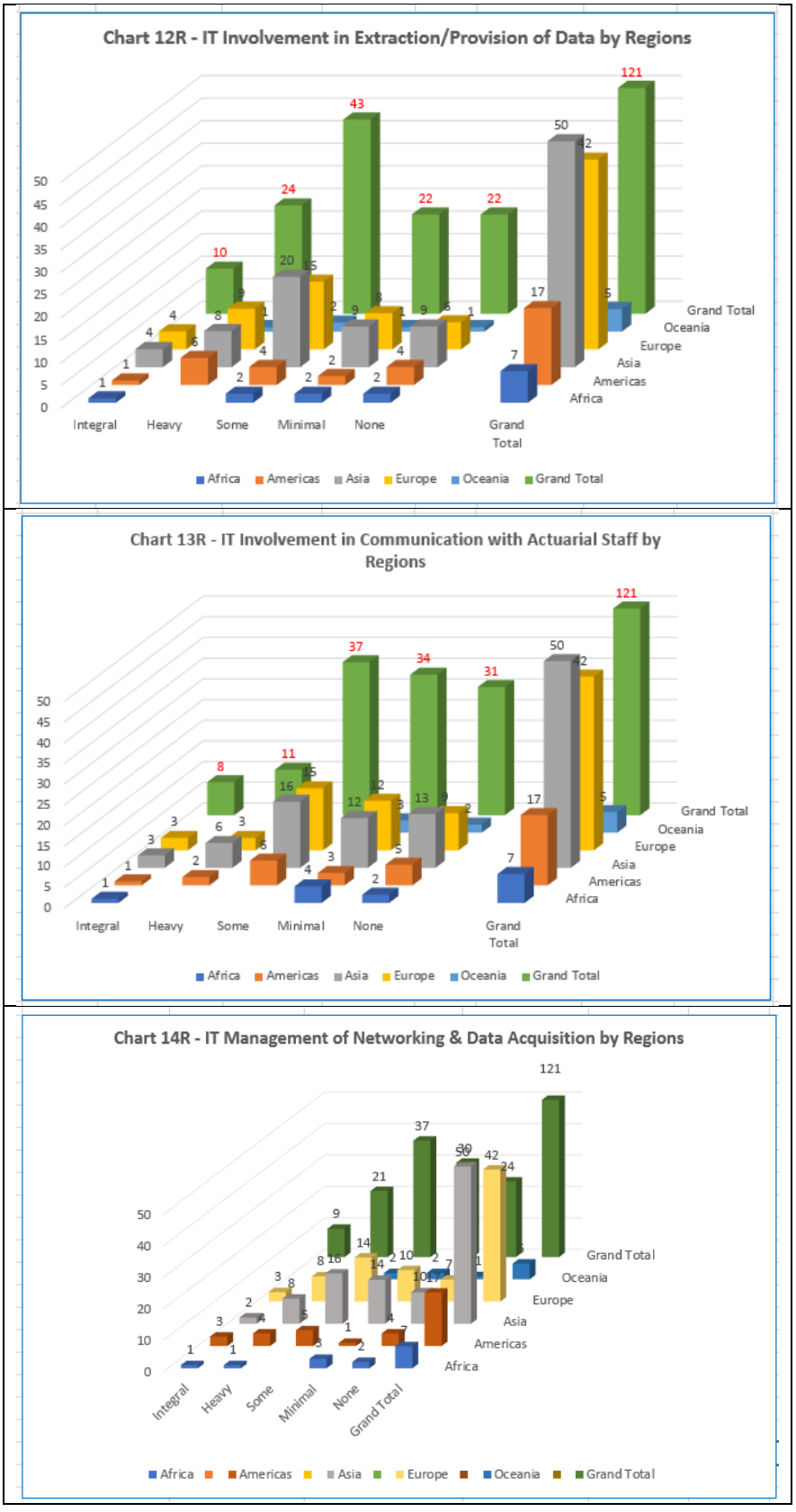


Chart 12R - IT Involvement in Extraction/Provision of Data by Regions
Integral
Heavy
Some
Minimal
None
Grand Total
Africa
Americas
Asia
Europe
Oceania
Grand Total
Chart 13R - IT Involvement in Communication with Actuarial Staff by Regions
Integral
Heavy
Some
Minimal
None
Grand Total
Africa
Americas
Asia
Europe
Oceania
Grand Total
Chart 14R - IT Management of Networking & Data Acquisition by Regions
Integral
Heavy
Some
Minimal
None
Grand Total
Africa
Americas
Asia
Europe
Oceania
Grand Total

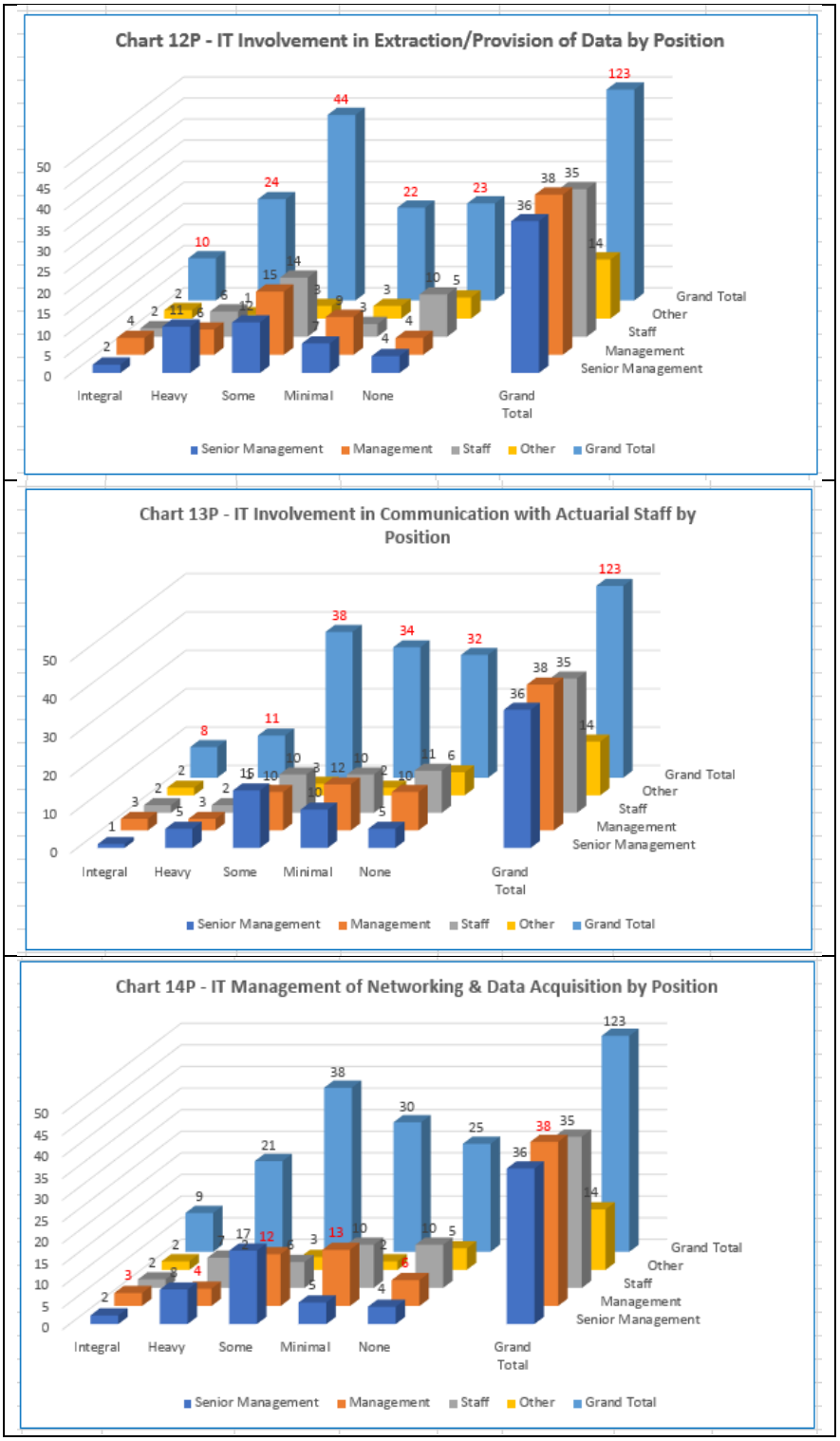


Chart 12P - IT Involvement in Extraction/Provision of Data by Position
Integral
Heavy
Some
Minimal
None
Grand Total
Grand Total
Other
Staff
Management
Senior Management
Senior Management
Management
Staff
Other
Grand Total
Chart 13P - IT Involvement in Communication with Actuarial Staff by Position
Integral
Heavy
Some
Minimal
None
Grand Total
Grand Total
Other
Staff
Management
Senior Management
Senior Management
Management
Staff
Other
Grand Total
Chart 14P - IT Management of Networking & Data Acquisition by Position
Integral
Heavy
Some
Minimal
None
Grand Total
Grand Total
Other
Staff
Management
Senior Management
Senior Management
Management
Staff
Other
Grand Total

3.1.3 Data analytics and decision making (q. 18-20)

Given the expanding role in which data analytics are being used for decision-making, the survey included the following three questions:

- Are strategic decisions made in your company supported by data analytics?
- How often do you foresee data analytics being a key driver of strategy in your company in the next three years?
- Who is most likely to adopt and push for improved analytics within your organization?

More than 50% responded that data analytics are sometimes used for strategic decisions, and another one-third informed that they are either mostly or always used for such decisions (charts 15R, 16R and 17R for region oriented responses, and charts 15P, 16P and 17P for the responses as given by different management position levels). Many respondents (115) indicated that data analytics would be heavily used for strategic decisions within the next three years. In responding to who will be most likely to adopt or push for improved analytics within the organization, there is a split among the 122 respondents: 38 responded the executive office, 35 indicated senior management, and 25 responded management. Another 24 respondents noted that staff are the most likely to adopt and push for improved analytics within their organizations. We surmise from these varied responses that data analytics are considered a strategic issue that is worth the attention of top management. Similar views were evident in the regional analysis, where the percentages of Asia, Europe, and the Americas were similar.

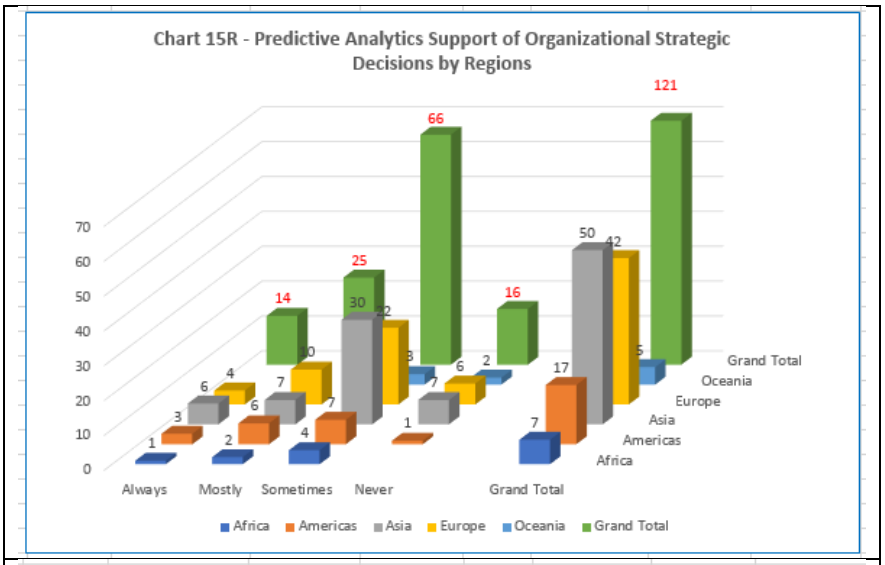


Chart 15R - Predictive Analytics Support of Organizational Strategic Decisions by Regions
Always
Mostly
Sometimes
Never
Grand Total
Africa
Americas
Asia
Europe
Oceania
Grand Total

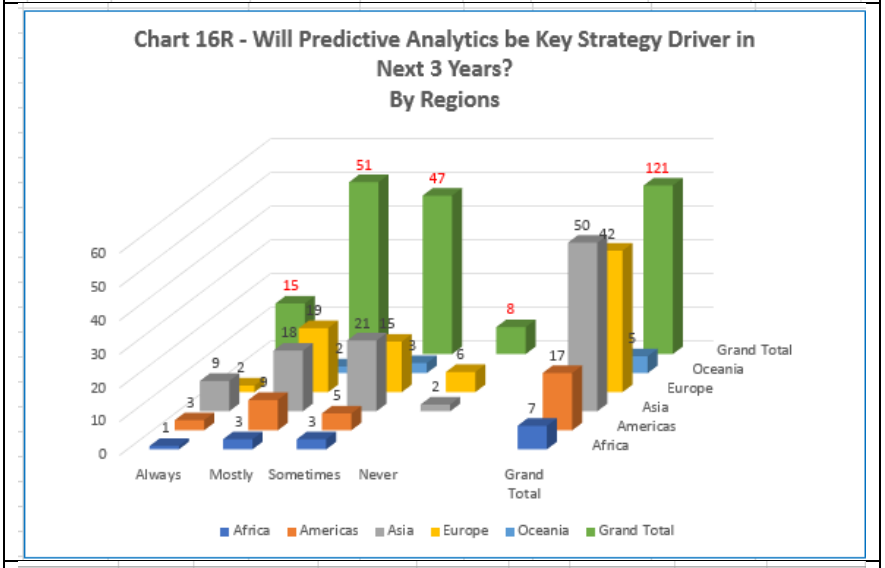


Chart 16R - Will Predictive Analytics be Key Strategy Driver in Next 3 Years? By Regions
Always
Mostly
Sometimes
Never
Grand Total
Africa
Americas
Asia
Europe
Oceania
Grand Total

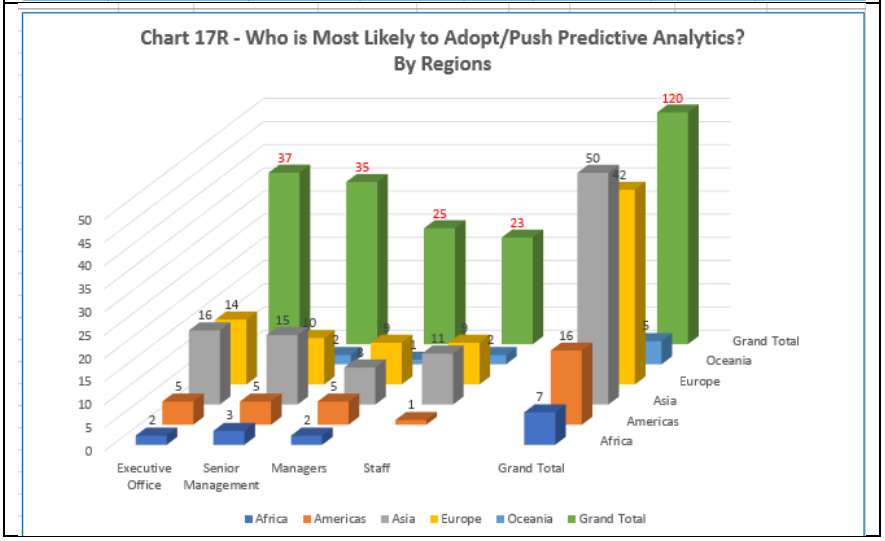


Chart 17R - Who is Most Likely to Adopt/Push Predictive Analytics? By Regions
Executive Office
Senior Management
Managers
Staff
Grand Total
Africa
Americas
Asia
Europe
Oceania
Grand Total

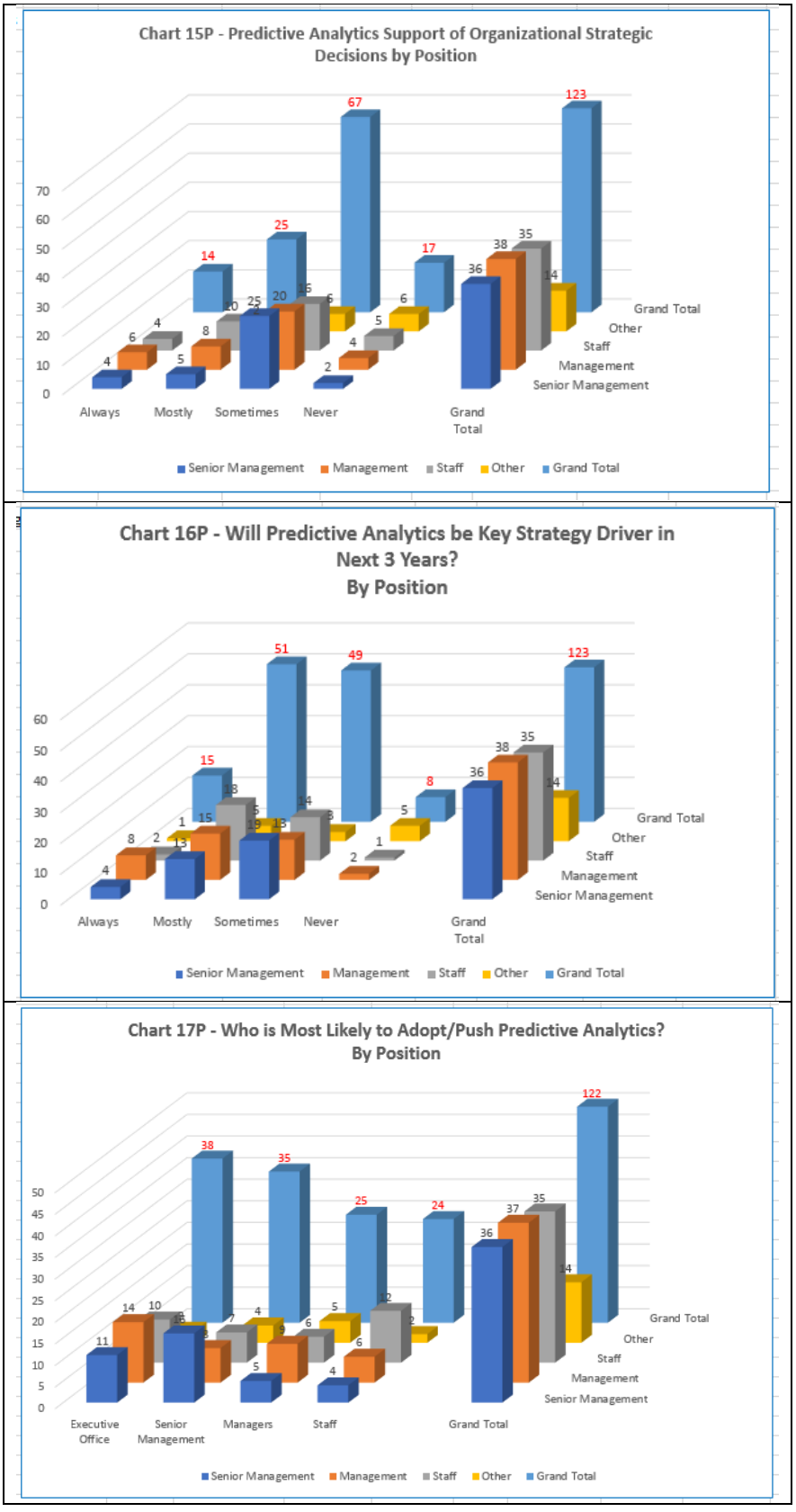


Chart 15P - Predictive Analytics Support of Organizational Strategic Decisions by Position
70
60
50
40
30
20
10
0
4
6
4
5
8
14
20
25
25
20
6
6
2
4
5
6
17
36
38
35
14
123
67
Always
Mostly
Sometimes
Never
Grand Total
Grand Total
Other
Staff
Management
Senior Management
Senior Management
Management
Staff
Other
Grand Total
Chart 16P - Will Predictive Analytics be Key Strategy Driver in Next 3 Years? By Position
60
50
40
30
20
10
0
4
8
2
13
1
15
15
13
13
14
51
49
2
1
5
8
36
38
35
14
123
Always
Mostly
Sometimes
Never
Grand Total
Grand Total
Other
Staff
Management
Senior Management
Senior Management
Management
Staff
Other
Grand Total
Chart 17P - Who is Most Likely to Adopt/Push Predictive Analytics? By Position
50
45
40
35
30
25
20
15
10
5
0
11
14
10
38
35
25
24
36
37
35
14
122
Executive Office
Senior Management
Managers
Staff
Grand Total
Grand Total
Other
Staff
Management
Senior Management
Senior Management
Management
Staff
Other
Grand Total

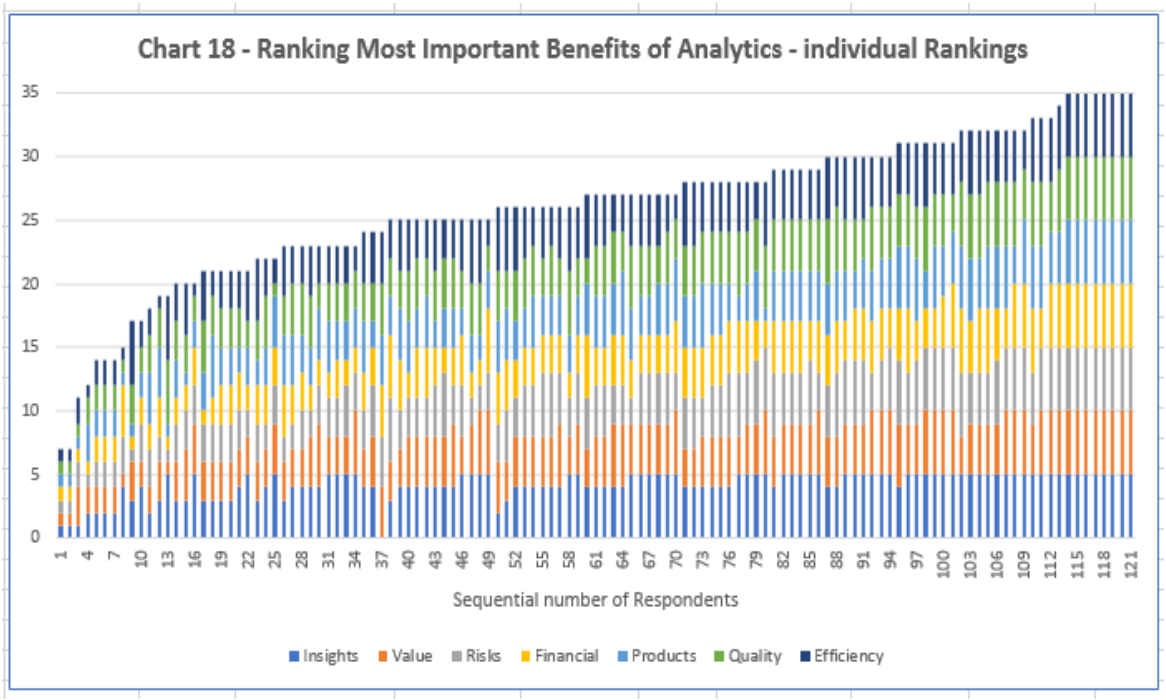
3.2 Data science benefits and barriers (q. 21-22)

3.2.1 Expected benefits from a data science Initiatives (q. 21)

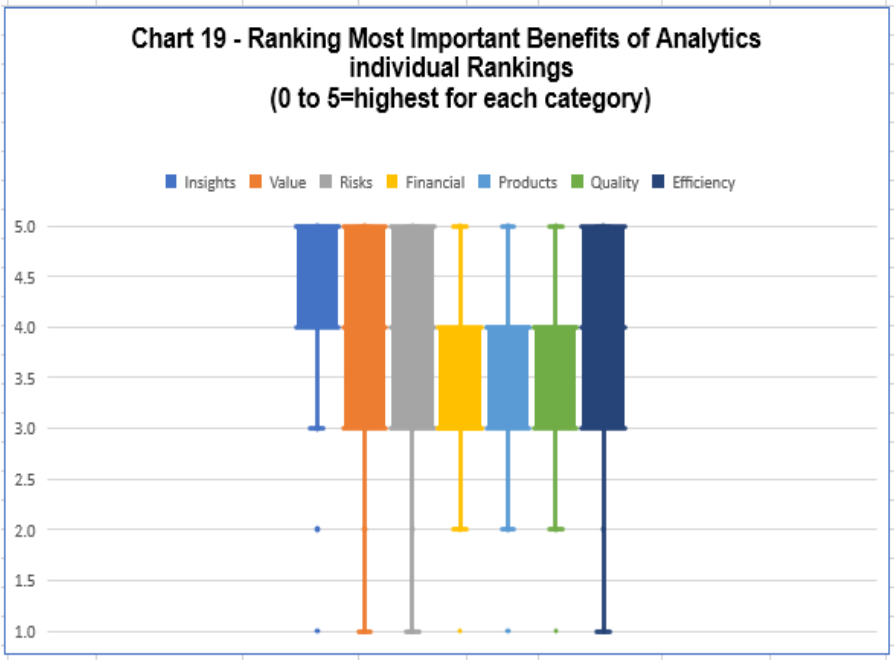
To better understand attitudes about the benefits of predictive analytics, the survey asked respondents to rank possible benefits. Seven possible benefits were suggested:

- Greater insights into data (Insights);
- Improved value to customers and business partners (Value);
- Identification of risks and ability to respond (Risk);
- Enhanced financial performance (Financial);
- Business and products opportunities (Products);
- Improved quality (Quality); and
- Enhanced efficiency (Efficiency).

The respondents were requested to rank each benefit from 1 (lowest) to 5 (highest), so that the maximal rank for a respondent approving all is 35. The following chart shows the individual rankings; each bar represents the response of one person, and the x-axis displays the sequential numbers of the 121 who responded. Each bar presents the rankings given by one person, starting at the bottom with Insights (in blue), above it Value (orange), with Efficiency (dark blue) at the top. The length of each of these sub-bars corresponds to the rank given – very short for 1, up to the longest for 5. The height of the whole bar for each person corresponds to the sum of these seven rankings. Few (15 out of 123) respondents had a total rank less than or equal to 20, while 35 had a total rank of 30 or above; the balance of 73 respondents gave a total ranking between 21 and 29.

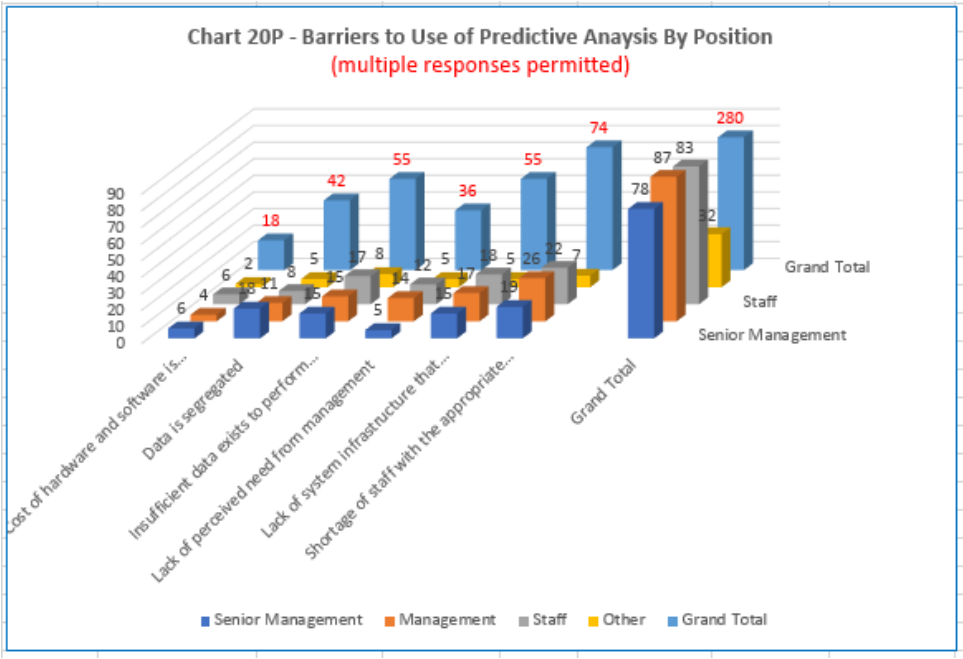


The following Box and Whisker chart summarizes the rankings. The box contains rankings between 1st and 3rd quartiles of the ranking's distribution, with values in the lowest quartile represented by the bottom whisker, and those in the highest quartile by the upper whisker Evidently respondents believed that insights, value, risks and efficiency are the top benefits that could be achieved from data science initiatives. Interestingly, financial outcomes were the lowest ranked benefit amongst possible benefit types. These trends were similar across both regions and practice areas.



3.2.2 Barriers to implementing data science initiatives (q. 22)

The respondents were also requested to identify the major barriers to the adoption of more advanced analytics (chart 20P). They listed the shortage of skilled staff as the most significant barrier (with 74 responses), followed by lack of appropriate infrastructure and insufficient data to perform analytics work (about 55 responses each). The next most highly noted barriers were the segregation of data (42) and lack of perceived need by management (35). These observations were persistent across regions and working position.

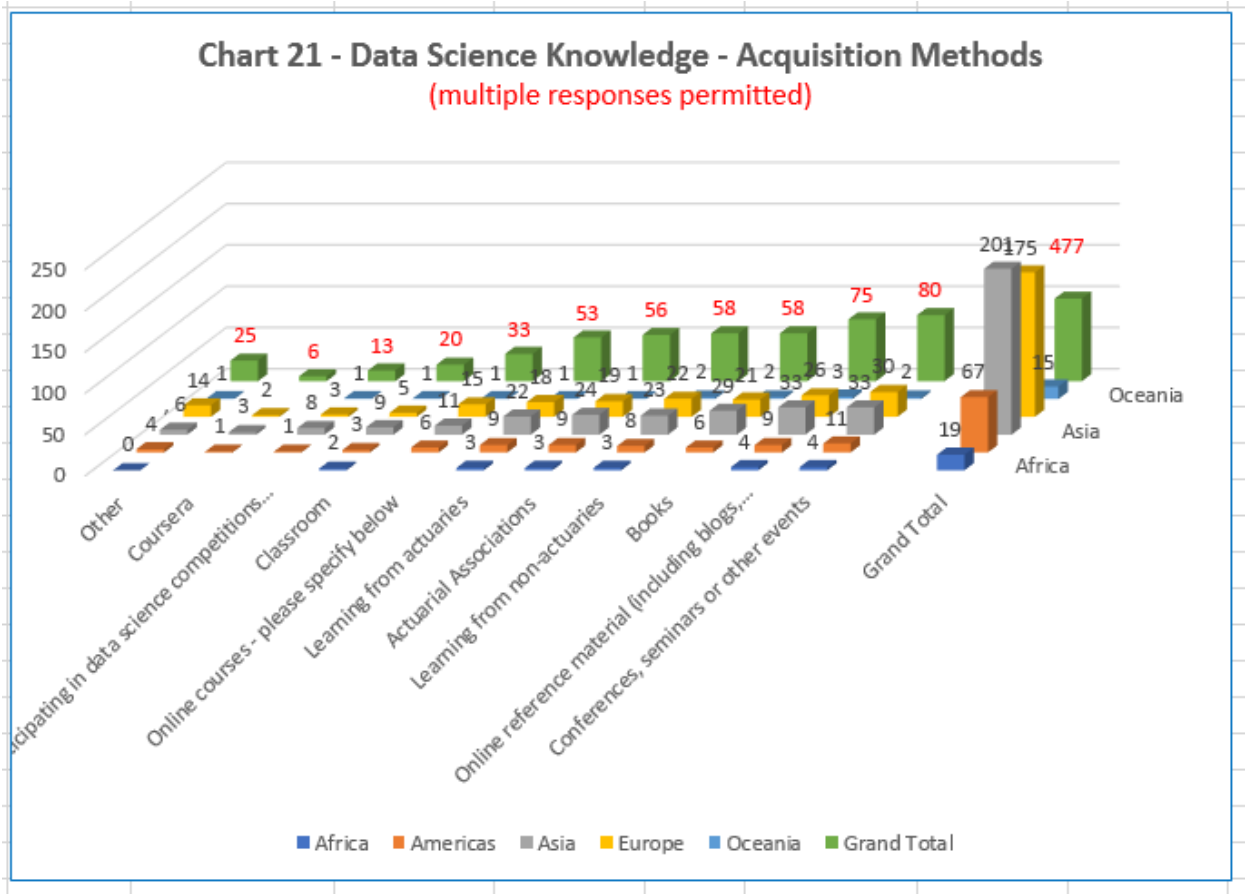


4. *Data science knowledge acquisition and use*

In the former chapters, the profiles of the respondents were described as well as the use of data analytics in organizations. This chapter completes the picture by reporting on how respondents learned about data science and what tools they use to conduct data analytics.

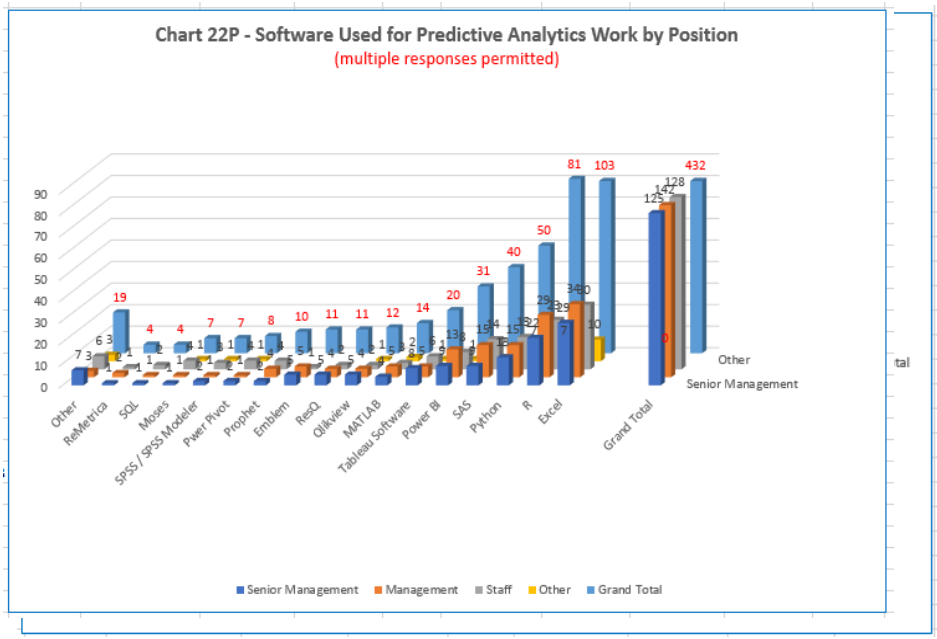
4.1 Acquisition of knowledge about data science (q. 13)

As noted at the beginning of chapter 2, out of the 123 respondents, most (83) were at least somewhat familiar with data science. Almost all respondents learned about data science and big data from conferences and seminars (80) or online (75) (chart 21). There are, however, many other outlets from which respondent learned about data science. Also, it seems that Europe and Asia display similar patterns in learning about data science.



4.2 Data science and software tools used to perform analytics (q. 23-24)

4.2.1 Software used to perform analytics (q. 23)



Excel and R are the favorite software used by respondents. Python and SAS are also used frequently by actuaries. The response rates related to Excel, R, Python, and SAS are about the same in all age groups, and they are the preferred tools in all age groups (chart 22A). However, all other software tools receive little use by the younger (below 30) and older (40 and above) actuaries.

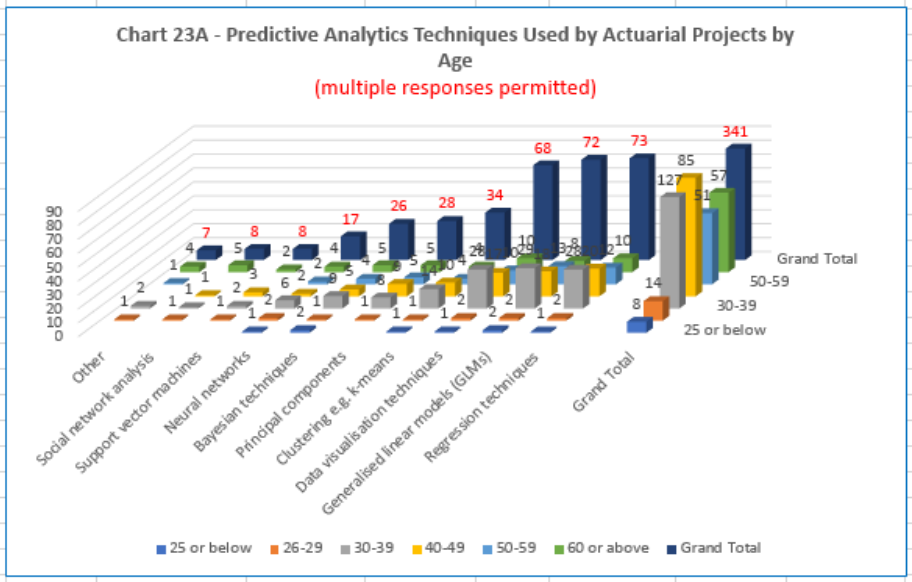
A related analysis of the use of software by the various position levels (from interns to senior management – chart 22P) and by years of experience, correlates well with the use by age group. One explanation for the high use of Excel is that older actuaries tend to have more experience, and thus often hold more senior roles in their organizations; these actuaries are comfortable using tools (such as Excel) that they have used for decades. Continuing this explanation, younger actuaries who are not yet in senior management roles tend to spend more time in analysis and are using tools (such as R and Python) learned through university and for their formal actuarial training.

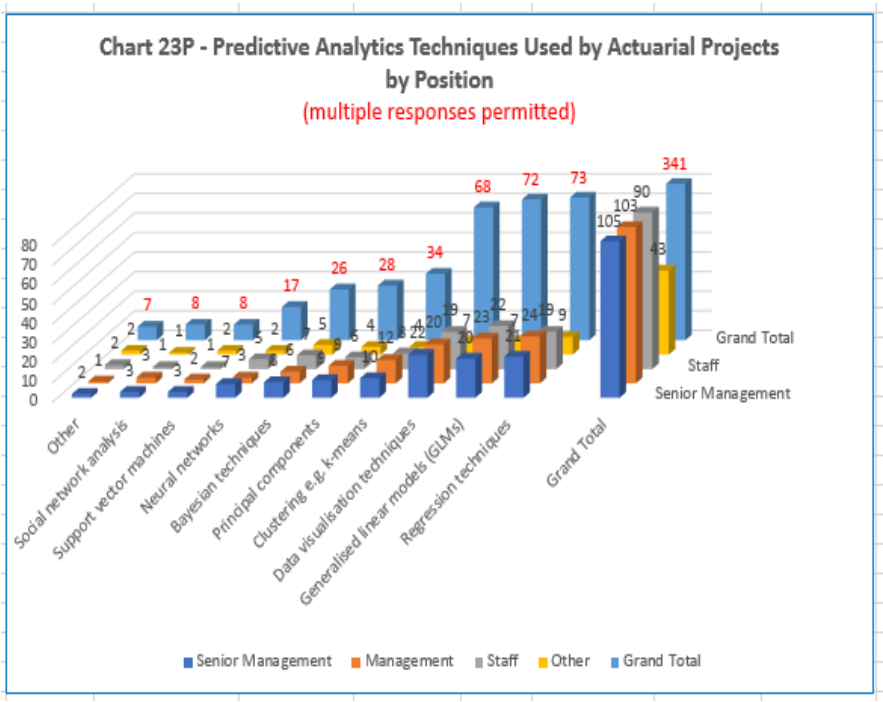
There are other explanations for the lower response rates for other tools. For example, there could be a low number of reserving actuaries who participated in the survey, which could result in a lower indication of ResQ use. Similarly, a low number of capital management actuaries participating in the survey could lead to a lower indication of Emblem use. Note neither ResQ nor Emblem are considered predictive analytics software tools.

Similar observations regarding the use of software are evident in Asia and Europe. The number of responses from the other regions is too small to observe a clear pattern.

4.2.2 Actuarial projects use of data science techniques (q. 24)

Chart 23A shows that traditional actuarial techniques, such as regression techniques, general linear models (GLMs), and data visualization, continue to be used extensively, and the main users are in the 30-49 age group. We observe lower use by older actuaries, who likely hold more significant roles in leadership than the younger actuaries. Similar observations persist when the use of predictive analytic techniques by position (chart 23P) is examined.





When regional use is considered, similarities are evident between European and Asian respondents. Again, the dominant techniques are regression, GLMs, and data visualization. Novel techniques, such as support vector machines, social network analysis, and neural networks, are hardly used, and that is true across all the regions.

4.3 Participants views (q.25)

A survey such as this one is naturally limited in the number of questions it can ask and the number of structured responses it can provide. In other words, the survey by its very nature is limited in its depth and scope of coverage. Therefore, the survey provided the respondents with an open-ended question for “further comments, additional information, and other issues to be considered.” Approximately 20 respondents provided additional information as requested. Below is a summary of some of the (unedited) comments:

- I think data science is very important for the actuarial work.
- There is a lot of value in moving the traditional actuarial reports to using a more granular big datasets, and I believe this skill set can change the way we as actuaries work with data. But there is also a cost benefit analysis that needs to be considered.
- Having worked both as a qualified actuary and data scientist in a cryptocurrency startup, I see limited use of data science in the actuarial field (particularly life insurance), due to the inadequacy of data, prohibitions from regulators, siloed IT department, lack of skills from actuaries, and limited profit potential of advanced data science techniques.
- Be careful about the use of artificial intelligence. It includes psychology, ethics, and many other fields – and actuaries are rarely trained in these disciplines.
- Data science is not only about tooling, it's about communication, connecting, customer needs awareness, goal setting, understanding, social skills, etc.
- A (major) barrier is the cost of software/hardware development. More likely than not, the cost comes in the form of time - as the existing staff are usually asked to develop this on top of their usual work.
- There is not enough time prioritized to "play around" with data science.
- If we just have more insurance datasets which are shared, we can get the skills of data science more easily.
- Use of data science in actuarial work can be challenging and difficult - much more so than other business, NGO and government uses. Such distinction needs to be well understood and communicated clearly.
- We need to improve the awareness of the team of aged managements about data science. Establishment of standard ethical check items / ethical codes are most desirable for data analysis.
- My company has started a project to propagate knowledge and use of R and data science techniques. However, actuary managers still don't appreciate the value of investment here. I think the actuarial bodies should push this more via conferences and seminars.
- We have been fortunate to have support from the Chief Actuary, acting as tool agnostic, and spending time individually trying to solve problems using data science that might be outside of standard remit.

5. *Summary comments*

The BDWG recognizes the need for and opportunities of data science technologies and their application to actuarial work. Furthermore, we believe that it is important to include relevant topics in actuarial educational programs to best prepare the actuary of the future. With this mindset, the BDWG conducted this survey, the first of its kind, with the objective of assessing:

- Attitudes of actuaries world-wide to data science, big data, and data analytics;
- Familiarity with emerging technologies; and
- Usefulness of advanced analytic tools in actuarial work.

The respondents also shared their opinions about the benefits, barriers, and adoption of analytic techniques. This report summarized the responses of the 123 participants. While additional relations and correlations between the answers may have gleamed further insight, we judged that the additional information would not materially add to the findings.

The respondents belonged to the IAA sections, committees, and others who consented to receiving e-mails from the IAA. Access to the much wider body of actuaries world-wide is not possible under the IAA rules.

Members of the IAA BDWG are aware that some actuarial professional organizations, particularly those in North America and Europe, are actively working in the area of advanced analytics. Their activities include, but are not limited to, changes in education (including basic and continuing education) as well as the introduction of new educational paths. Many of these actuarial organizations are addressing issues related to advanced analytics through committees, task forces, and working groups. Given that the BDWG did not have access to the global community of actuaries, the 123 responses to the survey likely do not represent the views of the global profession. Nevertheless, there is value in understanding the patterns and trends seen in responses to this survey.

We hope to further advance our understanding of the future role of data science in the actuarial practice, and conduct future similar studies, probably on a bi- or tri-annual basis, and hopefully in cooperation with other groups as noted above. In such follow-up studies it may be worthwhile to follow the penetration of data science tools and practices in various business and regulatory areas (e.g., banking, finance, consulting, and insurance) of different sizes (small, medium, large, multi-national), as well as to describe successful projects

Appendix:Survey questionnaire

Data science definition and scope:
Data science is the field of study that combines domain expertise, programming skills, and knowledge of mathematics and statistics to extract meaningful insights from data. Data science practitioners apply machine learning algorithms to numbers, text, images, video, audio, and more to produce artificial intelligence (AI) systems to perform tasks that ordinarily require human intelligence. In turn, these systems generate insights which analysts and business users can translate into tangible business value. - Source: DataRobot (https://www.datarobot.com/wiki/data-science/)

Question #	**Question Description**		
1-4	**Personal identification questions (such as name, email, country, etc.)**		
5	**Please indicate your age below:**		
	>25	26 - 29	30 - 39
	40 - 49	50 - 59	<60
6	**Are you a qualified Actuary?**		
	Yes	No	
7	**What level is your work position within the organization?**		
	Senior management	Management	Staff
	Intern	Consultant	Academic
	Other		
8	**How many years work experience do you have in your profession?**		
	<5	5 - 9	10 - 14
	15 - 19	20 - 24	<25
9	**What is (are) your practice area(s)?**		
	Life insurance	Pensions	General insurance
	Health and care	Risk management	Finance and investment
	Resource and environment	Statistician	Artificial Intelligence
	Marketing	Data Science	Information Systems
	Management	Other (please specify)	

10	**Which functions do you perform in your current role? (multiple selections allowed)**		
	Business Development	Business Intelligence	Management Reporting
	Marketing	Operational Modelling	Pricing
	Predictive Modelling	Product Development	Programming / Development
	Reserving	Risk Management	Telematics
	Underwriting	Claim Management	Regulatory Reporting & Compliance
	Support Activities	Other (please specify)	
11	**How would you best describe your familiarity with the data science universe? (Please select one of the following)**		
	I have heard of "data science" as a buzz word but I don't know what it means.	I have read about data science and I am aware of what it means but I have not used any of its key techniques or technologies.	I have tried out some basic data science techniques on a data set at work but have not used them to produce or support any actuarial findings.
	I have used data science techniques on a real data set for work in order to produce/support actuarial findings but do not use them regularly.	I regularly use data science techniques in the production of my actuarial findings.	
12	**What projects or activities brought data science to your attention and/or made you interested to know more about it?**		
13	**Which of the following methods have you used in order to find out more about data science or big data? (Choose all that apply)**		
	Conferences, seminars or other events	Actuarial Associations	Taught classroom
	Learning from actuaries	Learning from non-actuaries	Online reference material (including blogs, YouTube etc.)
	Books	Participating in data science competitions (such as Kaggle)	Online courses - please specify below
	Other (please specify) or comments		

14	**Who is responsible for the analytical work in your organization?**		
	Nobody specific, spread across various departments in unstructured manner	Some divisions that act in isolation	A centralized division / group that provide support to the organization
	A central division / group that oversees and supports analytics throughout the organization	Not Applicable	
15	**Describe the involvement of your IT department with regards to the organization's analytics/data science/big data activities in the following: extraction and provision of data**		
	None	Minimal	Some involvement
	Heavily involved	Integral	
16	**Describe the involvement of your IT department with regards to the organization's analytics/data science/big data activities in the following: communication with actuarial staff**		
	None	Minimal	Some involvement
	Heavily involved	Integral	
17	**Describe the involvement of your IT department with regards to the organization's analytics/data science/big data activities in the following: management of networking and data acquisition**		
	None	Minimal	Some involvement
	Heavily involved	Integral	
18	**Are strategic decisions made in your company supported by data analytics?**		
	All the time	Mostly	Some of the time
	Not at all		
19	**How often do you foresee data analytics being a key driver of strategy in your company in the next three years?**		
	All the time	Mostly	Some of the time
	Not at all		
20	**Who is most likely to adopt and push for improved analytics within your organization?**		
	Executive Office	Senior Managers	Managers
	Junior staff		
21	**The most important benefits of data analytics (Please rank in order of importance):**		
	Greater insights into data	Improved value to customers and business partners	Identification of risks and ability to respond
	Enhanced financial performance	Sales and product opportunities	Improved quality of results

	Improved efficiency		
22	**What is the greatest barrier to doing more advanced analytics?**		
	Shortage of staff with the appropriate skillset	Lack of system infrastructure that supports analytics	Lack of perceived need from management
	Insufficient data exists to perform analytics on	Data is segregated	Cost of hardware and software is prohibitive
23	**What software do you make use of to do analytics?**		
	Emblem	Excel	Julia
	MATLAB	Moses	Power BI
	Power Pivot	Prophet	Python
	Qlikview	R	Rapidminer
	ReMetrica	ResQ	SAS
	SPSS / SPSS Modeler	Tableau Software	Other (please specify)
	None		
24	**Please indicate whether you or your team use any of the data science techniques for actuarial purposes**		
	Regression techniques	Generalised linear models (GLMs)	Data visualisation techniques
	Decision trees, random forests, gradient boosting	Neural networks	Support vector machines
	Clustering e.g. k-means	Principal components	Social network analysis
	Bayesian techniques		
25	**Further comments, additional information, and any other issues to be considered (open ended response)**		