Automation in the Danish public sector

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1. Introduction

The evolving usage opportunities for artificial intelligence (henceforth AI) are creating footprints within markets and societies throughout the world. Much attention has been directed to how AI has the possibility to create an almost jobless society since work performed by humans can increasingly be replaced by virtual workforces. Automation, which is a technology that can be based on AI, especially poses an opportunity for the administrative-heavy public sector since automation can aid cost savings and increase efficiency by reducing administrative burdens and encouraging resource allocation (Eggers et al., 2017). The modern developments within automation further makes this technology relevant to the public sector since use cases are increasing (Purdy & Daugherty, 2016). The implementation of the overall offerings within AI is, however, struggling in the public sector due to limited and lacking recourses, human creativity, and trust in the government (Mehr, 2017). Nevertheless, Denmark is trying to confront this. While having one of the largest public sectors in the world compared to its size (OECD, 2017), Denmark has initiated a new AI strategy where the government strives to become: *"a front-runner in responsible development and use of artificial intelligence"* (The Danish Government, 2019). Hence, Denmark poses as an ideal country for further research into the current status of using automation in the public sector due to its relative size combined with their vision within the field.

In my research, I expect to find how automation generally has a positive effect on the public sector both in terms of employees being reduced or their resources allocated but also in terms of an overall positive return on investment. This assumption is based upon prior research which will be touched upon throughout the research proposal.

The implications of the attained results from this paper can enlighten policymakers, in as well as outside of Denmark, as they will get a better understanding of the current effect of automation and whether more resources should be allocated to this field. Furthermore, the citizens of Denmark may also find this research important since they stand to gain potential tax savings or better utilization of their paid taxes.

2. Research objective

AI is not a new field within research and much of its technological and theoretical foundation has been developed over the past 70 years (Purdy & Daugherty, 2016). Despite the large amount of research on AI, the public usage of AI and automation, in particular, is still a young field with lacking exploration (Wirtz et al., 2019). It is further seen how the majority of organizations are still in a test phase where the focus is on learning and piloting and not on defining business outcomes (EY, 2018).

Therefore, a comprehensive analysis of the influence of automation, in terms of jobs and return on investment, is necessary. Derived from empirical work by international business scholars and existing research, and in order to add to existing literature the following research question has been chosen:

How successful is the current usage of automation in the public sector in Denmark?

This paper will use a quantitative approach since this is the approach adopted by the majority of scholars in the same research field (Sousa et al., 2019). The research will look into the financial investments needed to implement automation compared with the financial savings it can potentially result in. Furthermore, the research will investigate the number of full-time employees or equivalents (henceforth FTEs) being reduced resulting from automation. The focus will be on the years 2014-2019 and the data will be obtained through the regions in Denmark and existing data online.

3. Empirical background

In order to comprehend the importance of this research, it is imperative to understand what automation is, what recent developments have resulted in and how it can be used in the public sector. The definition of automation is in the Cambridge Dictionary described as using machines or computers to do a job instead of humans (Cambridge Dictionary, 2020). However, automation has developed much recently, and the new AI-powered *intelligent automation* wave is already going beyond traditional automation. Intelligent automation is now able to solve problems across job titles and industries and not just specific repetitive tasks. Additionally, intelligent automation can self-learn which, for instance, removes the challenge of automation capital degrading over time (Purdy & Daugherty, 2016). This development will increase the usage opportunities of automation in the public sector. In a report on AI, developed by the US Government, it is further outlined why especially automation is the key driver in the public sector: *"AI's central economic effect in the short term will be the automation of tasks that could not be automated before"* (Holdren & Smith, 2016, p. 12). Diving deeper into the usage of AI and automation, McKinsey & Company (2017) has made a report outlining the potential of automation in the Danish labor market. This report looks at different industries in Denmark by having analyzed more than 400 different jobs and thereafter breaking this data down to more than 2,000 activity types and 18 human abilities. This analysis is then used to understand what parts of these individual jobs can be automated. Focusing on the long run, the report concludes that approximately 40% of the Danes' current working hours can be automated with existing technology. Looking at Figure 1, it is seen how the public sector isolated has the potential to automate 31% of their current working hours, which is the lowest percentage of the analyzed

industries. In contrast, hotels and restaurants rank highest on the graph with a share of 66% automatable activities. The public sector is below the overall average of 43% because the nature of the work in the different industries and jobs differ. Work being characterized by a large number of repetitive tasks has the biggest potential in terms of automation. But even though the public sector has the lowest share of automation potential, this sector represents the largest share of employment in Denmark. Figure 1 shows how the public sector represents 33% of the analyzed workforce which is a large share relative to the other industries. Consequently, this sector is highly relevant since it, due to its size, encompasses large savings which will benefit all Danish citizens (McKinsey & Co., 2017).

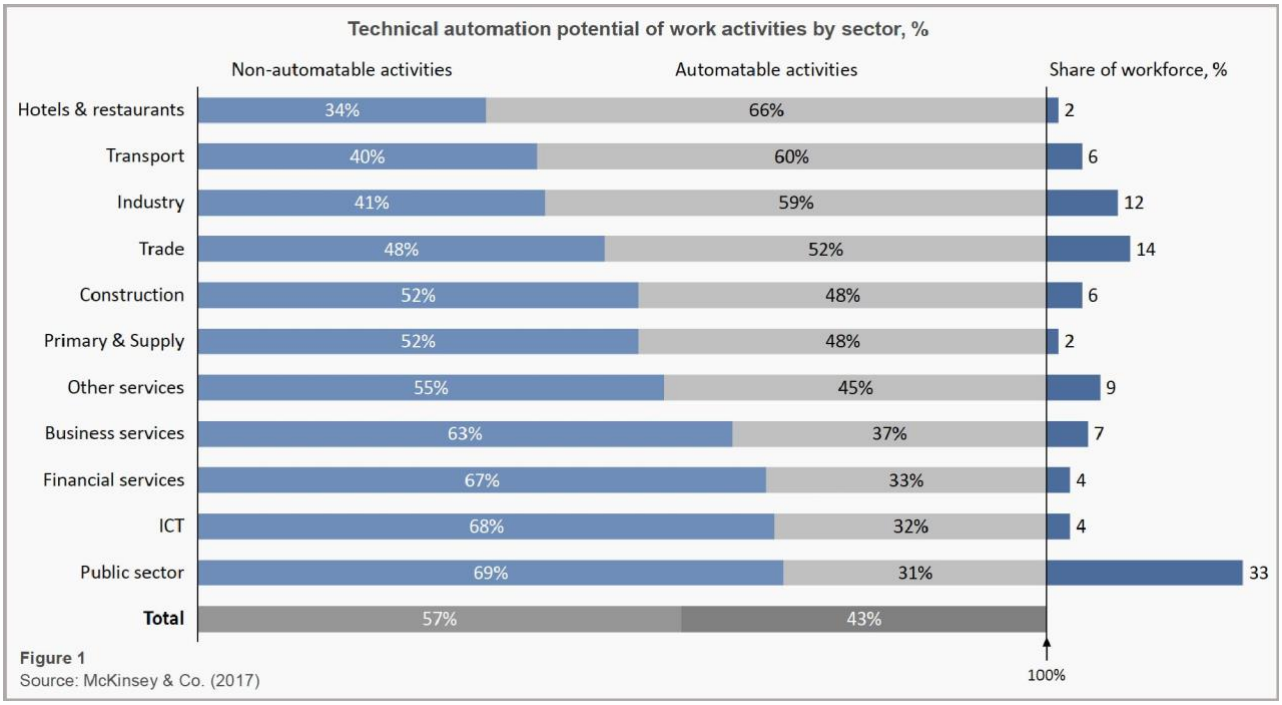

Figure 1
Source: McKinsey & Co. (2017)

Looking at Denmark from a global perspective, it has one of the largest public sectors among the OECD countries which can be seen through two important parameters. Firstly, 28.02% of the total employment in Denmark was in 2017 employed in the public sector, being the third-largest employment percentage in OECD in this sector (OECD.stat, 2019). Secondly, the Danish public sector uses the largest amount of money on salaries in OECD representing a total of 15.3% of Denmark's total GDP in 2017 (OECD.stat, 2019). This corresponds to 333 billion Danish Kroner (DST, 2019). If Denmark were to fully automate the proposed 31% of all working hours in the public sector, this would lead to approximately 103.2 billion DKK in savings if all hourly wages are assumed the same. This could either reduce tax pressure on citizens or it could incentivize resource allocation for better utilization of tax money, thus resulting in better and more efficient public services.

The research provided by McKinsey (2017) and OECD (2019) outlines the future possibilities of automation in the Danish public sector. However, this research does not focus on the current usage of automation or the results obtained so far, and research is generally lacking in this area. In a survey conducted by EY (2018), it was seen how the majority of organizations are not defining specific business outcomes but are instead focusing on piloting and learning within AI methods and technologies (EY, 2018). Thus, measuring the value and impact of AI is generally lacking. This, in turn, underlines the necessity for further research within this topic in a country and an industry that is yet to be fully explored, namely the public sector in Denmark.

4. Theoretical background

Many scholars of international business have researched the field of automation and its implications. Nevertheless, the current effect of automation in the public sector is yet to be discovered in depth and most research is only to be found only through case studies. Thus, the subsequent literature review seeks to situate the topic within a relevant line of former research, hence providing ground for the hypotheses to be further tested.

4.1 Applications and challenges in the public sector

Wirtz and colleagues (2018) have researched the application possibilities of AI in the public sector to map the value creation. Additionally, they have identified the main challenges of deploying AI in the public arena. This research has led to an identification of 10 AI application areas and four dimensions of AI challenges. One of the larger application areas under AI is "AI process Automation Systems" which has several functional propositions outlined. Value creation of this area includes supporting humans in tasks, mimicking human interaction with user interfaces of software systems, data mining, etc. While AI and automation has the potential to create value, certain challenges also persist. One of the branches of the four challenges mapped by the research is "AI implementation", which describes the dimensions that inhibit the progress of implementing AI in the public sector. One of the large barriers inhibiting the implementation is financial feasibility and insufficient budgets (PwC, 2017). Before creating and launching an AI application, the project is evaluated in advance in terms of its total costs and whether the AI solution is sustainably viable. In terms of the total costs, there are two main cost drivers. One being the investment in infrastructure to store and collect data (Roberts, 2017), and the other being the limited number of AI experts, resulting in increased costs on education and salaries (Bughin et al., 2017).

4.2 FTEs and human hours

When looking at the tangible benefits of deploying automation, FTEs or human hours are commonly used within research as a metric to measure the effect (Deloitte, 2017). FTEs can both be full-time employees or full-time equivalents since two part-time employees would then be counted as a single full-time employee. An automation consultancy company called Automation Anywhere has created several case studies outlining the result of the projects they have been employed on. All of their case studies include FTEs or human hours as one of the main metrics of measuring the effect of the automation project. One of their case studies outlines a project where they partnered up with a government-owned postal service, Australia Post. The objective was to find new pathways to manage accounting tasks and improve the efficiencies within the accounting department. The outcome of the project was an annual saving of 18,000 human hours (Automation Anywhere, 2019). This case study is one of many case studies outlining the FTE or human hour savings obtained from automation. It must be noted that the annual savings in human hours will not necessarily lead to lay-offs, thus the cost-savings will not in most cases be realized. Instead, the time savings will regularly result in resource allocation and better public service for the citizens (Eggers et al., 2017). However, one must also mention that even though many will face and are facing technological unemployment, the implementation of AI and automation has also been creating new jobs (McKinsey & Co., 2017). The emergence of these technologies has led to new job profiles such as data scientists and machine learning engineers (Wirtz et al., 2019). Different Danish municipalities also have dedicated teams to implement automation. By way of example, the municipality of Copenhagen has a team of seven FTEs employed to implement automation in the government (Casper Guldager, Senior Management Consultant). Based upon prior case studies and research the first hypothesis is as follows:

Hypothesis 1: *Automation investments have a significant impact on the number of FTEs.*

4.3 Automation ROI

Return on investment (ROI) is the metric used to evaluate the efficiency of an investment since it incorporates the benefit of a particular investment compared to its costs (Investopedia, 2019). Automation anywhere uses ROI in selected case studies to measure how fast an investment has paid for itself. By way of example, Automation Anywhere had a recent case study where the client experienced a return on investment of 1300% (Automation Anywhere, 2018). Furthermore, ROI is often used before implementing automation. Cooper and colleagues (2019) have researched the use

of robotic process automation[1] (henceforth RPA) in public accounting where they investigate both the current use but also possible future use of automation in this industry. Through interviews with RPA leaders from the Big 4 accounting firms, they found how ROI is one of the main considerations in determining whether to develop an RPA bot or not. It is standard practice that the accounting firms identify the possible ROI from implementing an RPA bot for a client before doing so, and they are generally very cognizant of this measure (Cooper et al., 2019).

In the case of the public sector, it could be very interesting to investigate the ROI of the various automation projects and how fast the investment paid for itself. This would be relevant since the findings can potentially enlighten policymakers and serve as grounds for investing more capital into this area. Based upon prior findings and research, the second hypothesis is as follows:

Hypothesis 2: *Automation investments will have a positive return on investment.*

4.4 Timeframe

Due to the nature of automation, the effects of this technology are not immediate which several scholars have outlined. When calculating cost savings, a broader timeframe should be taken into consideration in order to comprehend the full effect. Eggers and colleagues (2017) use a time frame of 5-7 years when outlining the cost savings of AI-based technologies in human services in the public sector. With a medium level of investment, they have calculated savings of $36.8 million in human service agencies which can be obtained within 5-7 years (Eggers et al., 2017). Based upon prior research and resources available a timeframe of five years (2014-2019) seems acceptable for this study.

5. Methodology

5.1 Population and sample

The population, to which the results will be derived from this project, is the public sector in Denmark. While prior research has, for instance, explored RPA in public accounting globally (Cooper et al., 2019) my research will investigate Denmark in particular and their adoption of automation. Denmark is a rather small country, but it has one of the world's largest public sectors which makes it an ideal country to be the unit of observation. When looking at Denmark, I will look into all the five regions in which Denmark consists of and further into 10 specific functions within the

Table 1

Classification of Functions of Government

F1. General public service	F6. Housing and community amenities
F2. Public order and safety	F7. Health
F3. Defense	F8. Recreation, culture, and religion
F4. Economic affairs	F9. Education
F5. Environmental protection	F10. Social protection

Source: OECD (2011)

[1] RPA: A branch of automation that mimics human actions

public sector (OECD, 2011) outlined in Table 1, in order to have a structured approach. Taking prior research into account (Sousa et al., 2019), these classifications of functions seem applicable. In terms of sample selection, a random sample is not possible due to the construct of wanting data from 10 specific functions within the Danish public sector. Hence, a convenience sample will be obtained.

5.2 Data collection

The data will be obtained from the government itself, and specifically, the departments who are handling the digital development of Denmark. Data already exist on previous automation projects. For instance, KL, the union for Danish municipalities, initiated an automation project under the auspices of a governance and efficiency program and the data from it is available online (KL, 2019). A contact from KPMG, who has done automation projects for the government, is willing to set up the communication with relevant people and further provide case studies conducted internally in KPMG for the research (Casper Guldager, Senior Management Consultant). The data collected will both be the associated expenses with the automation project but also the annual human hours or FTEs saved as a result of the project. Since the savings of human hours will not necessarily lead to lay-offs, thus not realizing cost savings (Eggers et al., 2017), the time reduction will still be accounted for in terms of salary savings in the data. The time frame of the data will be from 2014 to 2019. This period is chosen since the research objective is to outline current practice within automation.

5.3 Data analysis

The data analysis will consist of two parts; (i) a descriptive statistical analysis that aims to test hypothesis 2, and (ii) a regression analysis which aims to test hypothesis 1.

5.3.1 Descriptive statistics

A descriptive statistical analysis will be conducted in order to investigate the current status of using automation in the public sector. This is crucial in the process of gaining deeper insights into the performance of the public sector overall, while also identifying how the 10 different function areas are performing. The main variable being analyzed in this section is ROI since this key figure is an indicator of how efficient an investment is (Investopedia, 2019). It is calculated by:

$$ROI = \frac{Gains^{*} - Investment}{Investment}$$

**Gains will be the financial savings from salaries both realized and unrealized.*

Furthermore, gains and investment will also be analyzed as individual variables. The data is analyzed using mean, standard deviation, median, quantiles, and other important numerical summaries. This will provide a solid foundation for further research and a common understanding of automation usage in the public sector.

5.3.2 Regression analysis

The regression analysis will be used in order to draw statistical inferences to the population and to test hypothesis 2. The variables used for this analysis will be the following:

Dependent variable

The dependent variable in the regression analysis will be the FTE savings per project, which are the full-time employees or equivalents being saved as a result of automation. It is calculated by:

$$FTE\ savings = \frac{Human\ hours\ automated}{37 * 52^{**}}$$

***A Danish full-time position is corresponding to an average of 37 hours a week (Djøf, 2020), which is then multiplied by the number of weeks in a year equivalent of 52 (Accounting Tools, 2019).*

Independent variables

The investment per project will be the independent variable in testing for a correlation. The investment will be calculated as the salaries for the employee(s) conducting the automation project or the consultancy firm's chargeable costs. Additionally, it will also include other associated costs such as software, implementation of IT infrastructure, etc.

Control variable

A control variable will be imposed in the model to take confounding factors into account. To control for trends, year will be the imposed control variable since the use of automation can vary during different time periods. However, for further research, it could be interesting to investigate the development in the usage of automation over the years, but this is not within the scope of this study.

Finally, a two-sided t test is performed to determine if there is a significant correlation between automation investments and FTE savings. A significance level equal to 0.05 will be used in the test. Furthermore, the assumptions of the model must be checked either with a QQ plot or a residual plot and a histogram to ensure same standard deviation and a normal distribution of the data.

5.4 Limitations

The research proposal entails several limitations that must either be considered when inspecting the results or provide the basis for future research. First of all, it would pose a problem if the public sector does not have all the data needed. To draw a full picture of the usage and effect of automation in the public sector, I would need data on all automation projects in the 10 different function areas, and some projects might not have been recorded or some function areas might not employ automation. Secondly, it can be hard to measure the expenses associated with the projects. Either the project is executed by a consultancy or it is done internally. If done internally, it can be hard to measure expenses as many employees can take part of an automation project since automatable tasks must be tracked down. Other associated expenses can also be hard to identify. If not documented and accounted for correctly, it will be hard to determine the amount of time and resources spent on the project. Thirdly, measuring gains from automation projects can be difficult as well since the employee must know how much time was spent on the task before it became automated. This would be needed in order to calculate the salary saved from the project. Furthermore, the choice of sector and country is highly specific, and this might limit the applicability of this paper in other sectors and geographical areas. Lastly, choosing a timeframe from 2014 to 2019 can make the research less relevant since a lot can happen within AI when research commences in 2021.

5.5 Proposed time frame.

Time schedule for bachelor thesis, 2021																								
Task	Weeks																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Preliminary research																								
Create reading list																								
Review litterature																								
Edit research proposal																								
Adjust research question																								
Meeting w. supervisor																								
Collecting data																								
Building and performing statistical analysis																								
Empirical background																								
Completion of litterature review																								
Data analysis																								
Writing																								
Building graphs																								
Proofreading and revising																								
Proofreading (other than me)																								
Amendments and feedback																								
Final draft																								
Submit thesis																								

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