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NoOps – A Multivocal literature review

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Abstract

Traditionally, an organization had to have in-house servers and hardware to build a web application. This evolved into Cloud computing where the possibility for cost reduction and scalable data storage became a reality. With the introduction of cloud computing came a concept known as NoOps, or No Operations. This paper aims to take a closer look into what NoOps is and the benefits and challenges of NoOps. The authors identified three RQs that could help to give more insight into NoOps. Further we discussed the findings and RQs and lay out the way forward for future studies into NoOps. We also looked at artificial intelligence (AI) and how AI seems to be heavily linked with a true NoOps environment. With the lack of scientific studies into NoOps, a Multivocal literature review was selected as the method used to investigate the concept and its implications. We try to show voices both for and against NoOps. Further, we try to look at a misconception of what NoOps really is, what true NoOps could be. Finally we look at what requirements there are for companies wanting to go NoOps, and discuss the possibility that many companies unknowingly are moving towards a NoOps environment.

Keywords: NoOps; Cloud computing; Serverless; AI; Artificial intelligence; Evolution IT;

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1. Introduction

In the world today we are surrounded by technology. The last 20 years of technology development have involved several technologies [1]. Also, trend words such as cloud computing, DevOps, serverless and NoOps have emerged. From the traditionally in-house servers and infrastructure set up, many companies now use different outside services such as infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS) and software-as-a-service (SaaS) [2]. Therefore, Cloud computing has now become one of the most important modern day technologies, with its possibilities for cost reduction, scalable data storage and reduced infrastructure maintenance cost [3]. By providing a pay-as-you-go model, Cloud computing enables cheap and easy access for companies to technology infrastructure [4].

Especially cost reduction is a key factor for companies. According to Forbes [5] the amount of time, money and resources spent on ongoing maintenance and management is affecting the overall competitiveness. Also, speed is one of the main factors for companies' competitiveness. It is clear that we, as customers, in today's market both expect and demand fast delivery, easy service and always availability. According to one report by Harvard business [6] they cite a study from McKinsey which states; if a company is late with a new product by up to six months, they risk earning 33% less over a five year period. This could explain the development and evolution of cloud computing. From the traditional way of keeping servers and infrastructure in-house, with the cost of acquiring and maintaining such infrastructure, to cloud computing where you pay for the service, thus freeing you from the need of keeping servers and infrastructure.

Economically and operationally there is a natural progression to cloud computing. In order to adapt to the ever changing and increasing customer demands, companies were forced to change the way they thought and organized their IT infrastructure. A move away from the traditional siloed setup between developers and operations teams was needed [7]. This led to a new term being coined in 2009 by Dubois [8]. By combining development and operations, a new term called DevOps was established. Traditionally these two teams worked separately. Developers focused on the code and operations would focus on taking that code and making sure it were running [9] [10]. With DevOps, these two now worked together by integrating tasks, knowledge and skills to better plan, build and run software, and thus ultimately speed up the whole process [9].

To further reduce time and cost, DevOps required more automation and less infrastructure [11]. This has brought about a new way of developing and deploy applications [4]. NoOps, often called Serverless, can be described as "A new paradigm that provides a platform to efficiently develop and deploy applications to the market without having to manage any underlying infrastructure" [12]. NoOps stands for No Operations and means a scenario, or environment, where there is a fully automated and self-manageable IT infrastructure capable of changing according to business and user demand, while keeping costs at a minimum [13]. By utilizing Function-as-a-service (FaaS), the idea is to completely remove the operations team, or human employees, and instead use machine learning (ML) and artificial intelligence (AI) together with a cloud provider. [14] . One interesting statement by Manyika et al. [15] claims that "advances in artificial intelligence and machine learning are making it possible to complete tasks that have long been regarded as impossible for machines to perform". That statement is amplified even greater by a more recent article. According to Kaplan and Haenlein [16] we are now on the verge of the second generation of AI, capable of reasoning, play and solving problems autonomously for tasks they were never designed for.

This paper will look at NoOps and its benefits and challenges. It would also be interesting to see if we could identify what requirements there is for a company wanting to go NoOps. Using both academic and grey literature we will try to get a clearer view of NoOps and present a definition of the term NoOps.

The rest of this paper is organized as follows. Section 2 presents the research questions the authors identified. Section 3 provides an overview of the methodology used in this paper and why. Also, the section includes the search string and search engines used, exclusion and inclusion criteria and the selection of relevant literature used in this paper. Section 4 discusses the findings and answers the RQs stated in section 2. In section 5 we summarize the findings. Section 6 presents the conclusion, and we look at different ways forward for more research into NoOps.

2. Research questions

To achieve the goal stated in the introduction section, there is a need to formulate research questions. We have identified three research questions that will be the main focus in this paper.

RQ1 -What is the definition of NoOps?
RQ2 - What are the benefits and challenges of NoOps?
RQ3 - What are the reported requirements for organizations adopting NoOps?

3. Methodology

To the best of our knowledge, the impact of NoOps in scientific literature is limited. So, the authors have opted for a Multivocal literature review (MLR). With a MLR approach, the combination of both academic literature and grey literature should give a better opportunity to answer the stated RQs. With grey literature the source of information will also include blogs, websites and white papers [17].

This section of the paper will be organized in the following way; Defining the search, search words, search engines and keywords

3.1. Defining the search

Following the guidelines for MLR for including grey literature there is a need to define the search process. There are two key factors in defining this aspect; [1] search string and [2] Search engines.

3.1.1. Search string

An online search for the keyword NoOps lists very few academic reports and a lot of grey literature. To catch a broader number of documents, keywords has to be identified . Initially, we wanted to identify all the relevant keywords of the RQs to be added in the final search string. Keywords such as development, evolution, benefits, challenges and requirements were considered. However, since there are very few scientific papers on NoOps, narrowing the search too much will not provide any relevant results. For simplicity and relevance, the final search string will therefore be as follows;

"NoOps" OR "NoOperations"

3.1.2. Search engines

For search engines, Google Search will be the preferred choice for finding grey literature. According to Statista [18] Google has a 92.47% market share and has dominated the search engine market since its introduction in 1997.

To find relevant scientific literature on NoOps, the following databases were selected:

- ACM Digital Library (http://dl.acm.org)
- Science Direct (http://www.sciencedirect.com)
- Springer Link (http://link.springer.com)
- IEEE Xplore Digital Library (https://ieeexplore.ieee.org)

These were chosen both for relevance in the field along with their accessibility by institutional accounts.

3.2. Inclusion and exclusion criteria

After the initial search string was run in every one of the databases described above, together with Google, a total number of 163 305 hits were found, as depicted in Table 1. The majority of these came from grey literature search. Non-pertinent results were removed by applying the following inclusion/exclusion criteria:

INCLUSION CRITERIA:

- Results that discuss NoOps
- Results that mentions NoOps as a next step
- Results that are accessible by means of the institutional accounts
- Results that are written in English

EXCLUSION CRITERIA:

- Results that does not discuss NoOps
- Results that does not mention NoOps as a next step
- Results that are inaccessible
- Results not written in English

3.3. Selection

After the initial results, we looked at findings using keywords and relevance. As a result, only 2 studies from scientific articles were left. By following the same steps on Google search findings, the total results were 22. This is shown in table 1. The 20 findings in Google search consists of the 20 most relevant grey literature presented by Google. These were published between 2017-2021.

Table 1 – Overview initial paper selection

	Initial search	Keywords/Abstract/Relevance	Full text
Google search	162 000	5 850	20
ACM Digital Library	85	40	0
Science Direct	382	28	0
Springer Link	837	25	1
IEEE Xplore	1	1	1
Total	163 305	5 943	22

4. Analysis of the results

In this chapter the answers of the three RQs are described. Relevant literature will be discussed in regard to each RQ. Most of the literature found consists of grey literature.

RQ1 -What is the definition of NoOps?

DevOps with automation: If we look at DevOps, there is a certain level of automation already in place. Automation in DevOps boosts speed, consistency and time-to-market [19]. With NoOps we have DevOps freed from the operations part [4]. This means offloading the company its management and operations tasks and shifting this to the cloud provider instead. Therefore ensuring companies can focus more on the product development tasks [4].

In a NoOps environment, human employees are removed from the traditional tasks like monitoring servers, maintenance and security.

Based on the literature we have reviewed, there is a slight difference in how NoOps is defined. Looking at the top results from grey literature, there is a consensus about the definition of NoOps. According to that, NoOps is a concept where the environment is so automated that there is no longer any need for an operations team. However, according to the scientific studies we looked at, we can define NoOps as a strategy that involves developers and operations working together without the infrastructure, delivering faster and better software, with a higher degree of quality. This means that server and infrastructure management is removed from the company and taken care of by the cloud provider [4]. The result is that companies can now focus solely on the coding. For simplicity, it is DevOps freed from operations. One of the reasons for this difference in definition could be explained by the fact that grey literature is often biased, while scientific texts is not [20].

RQ2 - What are the benefits and challenges of NoOps?

Benefits:

Advantages: Compared to a DevOps strategy, NoOps has 3 advantages; (1) No continuously running services are required, (2) Functions are only charged when they are executed as a pay-as-you-go, (3) the abstraction of function means increased productivity for developers [4]. These advantages are also equal for Serverless. Grey literature has Serverless as something different from NoOps. According to [21], NoOps is only a theoretical concept. However, Jindal et al. [4] describe these two as the same.

Reduced cost: Traditionally, companies have used up to 70% of ITs budget in keeping technology systems running according to one report from Deloitte [22]. Further, they describe the use of storage, cloud and outsourcing as tools to lower that budget outlay by 20% or more. The vision is that NoOps will speed up the process and also be a cost-effective way to streamline IT management.

Six strategies can be implemented for organizations in order to reduce cost [23]:

1. Moving to cloud-based service
2. Implementing a higher level of automation
3. Shifting staff to outside contractors and consultants
4. Implementing DevOps and Agile practices
5. Using microservices, containers or virtualization
6. Extending ITSM (information technology service management) to more parts of the company.

Focusing on strategies 1, 2, 4 and 5 there is a clearer understanding why cloud computing has become more important. As stated by BMC under strategy 1; “Cost reduction occurs when you move on-house servers and services to the cloud”. Furthermore, they claim under strategy 4; “focusing on faster time-to-market, lower failure, rapid updates and fixes – infrastructure built around improving application and service delivery rather than on managing servers” [23]. There is no doubt that cost matters, and reducing the cost becomes one of the main factors for organizations. Since NoOps can scale up or down automatically based on usage, this means that total costs are reduced [4]. Companies pay for what they use compared to the traditional setup where costs were constant.

However, comparing DevOps and NoOps cost reduction, we see there is a difference. Both strategies are cost effective but in their own way. A combination of DevOps and microservice strategies listed above, could be better for long lasting services [24]. NoOps, because of its scaling ability, which we will look at below, could be more suitable for requests with large size response [24].

Scalability: One of the key differences between NoOps and other cloud models is scalability [4]. This means that NoOps can increase/decrease as needed, linked with how many users access the system. With typical Cloud functions such as pay-as-you-go, FaaS, and backend-as-a-service (Baas) this will enable companies to both reduce cost, as mentioned above, and streamline IT while saving time, as will be shown below.

Time saving: Traditionally, developers and operations teams worked separately, going back and forth before launching. This changed with the introduction to DevOps. Developers then just made the code and sent it in. Changes to the code and new fixes were done “on the fly” with both development and operations working closely together with better understanding between them. This saves time from the traditionally back and forth set up many companies used before. Going further, from DevOps into NoOps, we end up with an environment where deployment is even more speed up. By removing operations team and implementing more automation, we get a scenario where, once the code is entered, everything is taken care of. Maintenance, debugging, changes, security, troubleshooting.

Challenges:

Automation is becoming increasingly important today. Already we are interacting with chatbots, virtual assistants, online shopping guide and other simple versions of AI. With increased automation and NoOps, a few challenges needs to be looked at;

What happens to surplus employees? Introducing NoOps in an organization means less demand for an operations team. This is also mentioned as one of the benefits with NoOps by streamlining IT and reduction of cost. However, the operators are still employed and still cost the same as before NoOps. There are sources that claim with NoOps, the operations team can focus on what they do best: project management and talent acquisition [25]. While this is true today, it might not be so in the coming years. With the goal of NoOps being to reach a certain level of automation, there is no longer any need for the operations team [26].

Going from DevOps to NoOps: For companies already utilizing DevOps as a strategy, there might not be enough benefits of going NoOps. As highlighted under RQ1, DevOps already has a certain level of automation with increased speed and time-to-market. A recent study showed that neither DevOps or NoOps fits all scenarios [4]. Both has its advantages and disadvantages. The study claims that DevOps is better for simple web-based requests while NoOps has an edge with compute-intensive applications [4].
However, NoOps has a key factor which DevOps does not have; Scalability, as shown under RQ2 – benefits. One way for companies to get all the benefits of both is to implement a hybrid solution. This will ensure that the optimal tool is selected dynamically, based on workload and need [4].

RQ3 – What are the reported requirements for organizations adopting NoOps?
One of the main requirements for both DevOps and NoOps is the need for a new way of thinking IT. NoOps is not a platform, nor a single technology or outsourcing your IT operations [14]. It is more a strategy which involves a rework of IT and workflow. For companies already applying DevOps strategies, the transition to NoOps is easier compared to the ones that does not. With DevOps, companies have already started moving to the cloud with the use of cloud service models such as Software-as-a-Service (SaaS) and Platform-as-a-Service (PaaS).
To make the move to NoOps, or Serverless, they would need to implement services such as Function-as-a-Service (FaaS) and Backend-as-a-Service (Baas) [4]. These two services enables the NoOps environment. With FaaS, companies can develop, run and manage apps without the need for on-site infrastructure [21]. They upload the code to the cloud provider and the FaaS platform is then responsible for deploying and facilitating the needed resources for the applications . Therefore, we end up with a solution that is both scalable in resource allocation and provides a pay-as-you-go model, or NoOps (Serverless). The cloud is responsible for providing the necessary resources, and perform automatic scaling based on user frequency and workload [4]. With BaaS, services such as authentication, cloud storage and databases management are handled by the cloud provider [21]. These backend products further enhances the NoOps environment.
For a company not currently using DevOps, the move to NoOps will take longer and require more in the way of thinking IT. The first step is to start using the cloud by connecting to services instead of being self-managed. Furthermore, they should invest in automation in order to simplify deploying, monitoring and improvement of the software [27].

5. Summary

The aim of this paper was to take a closer look into NoOps. By conducting a multivocal literature review, the researchers wanted to look at both scientific and grey literature. Since there is very little scientific papers written about NoOps, MVLR was the obvious choice. The researchers briefly introduced the concept of NoOps and the evolution of Cloud computing while also taking a brief look into artificial intelligence. We took a look at DevOps as an evolution of cloud computing and discussed how this is linked with NoOps and Serverless. Three research questions were identified and discussed.
Through the RQs we defined NoOps as DevOps freed from operations. We also looked at benefits and challenges of NoOps. The benefits listed in chapter 4 is also connected to DevOps. Benefits are reduced cost, scalability, and time saving. While these benefits are also true for DevOps, NoOps has the benefit of scalability which separate it from other Cloud models. It is conceivable that these benefits gets even more beneficial with NoOps since we could automate more and remove human intervention.
Looking at the challenges of NoOps, we focused on surplus employees and moving from DevOps to NoOps. It is quite clear that more automation will eventually reduce the need for employees. In the start surplus employees can be shifted

to other areas and assignments within the organization. But sooner or later surplus employees will become just that, surplus.
For a company to move from DevOps to NoOps there have to be some correlation with what kind of services that company provides. Both DevOps and NoOps have their advantages. A hybrid solution were both are implemented could be the way forward for most companies.

6. Conclusion and the way forward

There are some clear benefits of going NoOps but, as we have shown, many of these benefits already exists with DevOps. Regardless, NoOps is a very interesting strategy to implement, with its advantages and disadvantages. As shown under RQ1, it is DevOps freed from operations. Still, it has critical voices claiming this to be nothing more than a vision. There is also a lack of correlation between grey literature and scientific studies. Grey literature describes NoOps as a separated concept from Serverless, while studies of NoOps describe these two as the same strategy. This further enhances the need for more studies into NoOps. One interesting conclusion that we can draw from looking at both grey and scientific literature, is that NoOps could be something like Serverless + DevOps. Combining these two strategies could form the NoOps environment we have described in this review. It is highly recommended that future studies into NoOps also take a closer look into this path.
Another interesting direction for future studies could be NoOps with AI. It is very possible that in the future we might end up with a situation where NoOps and AI gets so integrated that it creates a NoIT environment. Currently there is not an AI advanced enough to further evolve NoOps.
Since its beginning, AI are now doing tasks previously thought impossible for machines to do, according to Manyika et al [15]. If we reach stage two and three of AI, as mentioned by Kaplan et al. [16], it is conceivable that we will see unpredictable possibilities unfold. To better understand how we can eventually end up with such a scenario, we need to take a look at AI, both where it is at and where it is going. According to Kaplan et al. [16] we are in stage 1 out of 3 of AI.

Stage 1 – Artificial Narrow Intelligence (ANI): In stage 1, AI is weak and below human level. We have a specialized AI capable of performing certain tasks it is told to do. Virtual assistants like Siri, Goggle and Alexa can recognize your voice and play music or do simple tasks. This is the stage we are currently in. AI can only perform as it is programmed to.

Stage 2 – Artificial General Intelligence (AGI): Once we reach the second stage, we will have Artificial General Intelligence (AGI) and a strong, Human-level AI. At that level it is very likely that NoOps will really start to flourish. Here we could start to see real extreme automation. AI in stage 2 can replicate humans and our multi-functional capabilities [28]. This will no doubt contribute to more areas where AI takes over human labour.

Stage 3 – Artificial Super Intelligent (ASI): At stage three, we have Artificial Super Intelligent (ASI) that outperforms humans in all areas. The effect and implication of this stage is hard to predict.
There are different opinions when we will reach the third and final stage. Futurist Ray Kurzweil [29] predicts this will happen around 2045. Others claim, with the advances in quantum computing, that this stage is much more imminent [30]. However, what is certain is that AI will continue to evolve and will bring opportunities and possibilities currently unpredictable for humans. Once we get human level AI, there should be no reasons why companies would not implement more AI and more automation. It will be cost effective compared to human employees, fast and reliant and always running. According to Huang et. al.[31] AI will eventually be a threat to human employment.

What is clear, is that we are at an exciting time in technological evolution and the near future could hold the promise of a human-computer connection. NoOps needs more research. It is quite possible that in the near future as we get more automation and advanced AI, more scientific papers will be written about NoOps. Also, it would be very interesting to conduct a case study of one or more organizations currently implementing NoOps.

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