DevOps: Profile Alignment and Measurable Information Technology Outcomes.

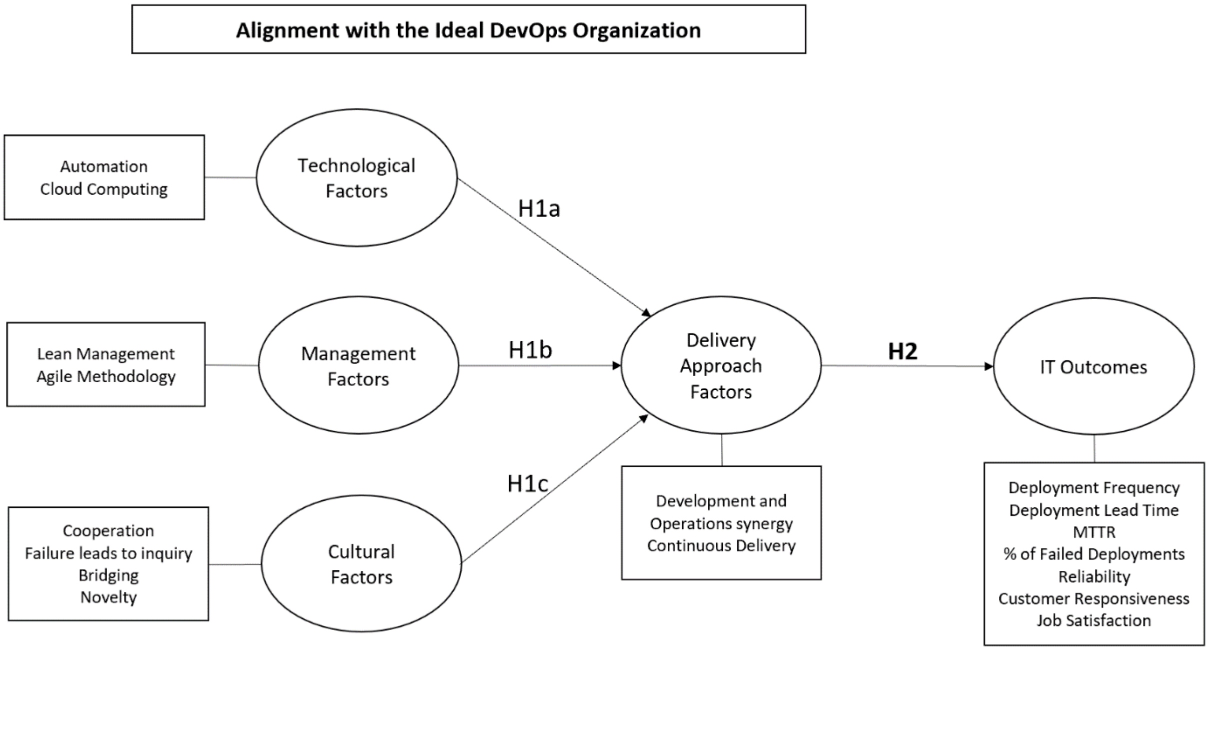
Summary of Dissertation by Gabriel Cogo

## INTRODUCTION

Organizations in the dynamic marketplace keep changing, and Information Systems (IS) have been instrumental in this change. A new paradigm called DevOps has been proposed to bring together different parts of the organization to deploy code faster, with higher quality and fewer mistakes (Erich, Amrit and Daneva 2014). The name DevOps comes from the junction of IT Development and IT Operations (Kim, Behr, Stafford 2014), but entails so much more than just bringing these traditionally separate processes closer. Indeed, DevOps entails complex changes in the way IT works and how the organization should develop and deploy software. DevOps had a US$4.3 billion growth in 2018, and industry expectations say that DevOps can save fortune 1000 firms at least US$91 million per year by improving IT indicators alone. Despite recent attention, however, it is still unclear what DevOps is, what it does, and how it leads to improved performance.

The goals of this research are twofold. The first goal is to understand and characterize DevOps, based on both academic and applied literatures. The second goal is to investigate which factors are involved with adopting DevOps, and which are the measurable IT outcomes impacted by DevOps inside the organization. The present research contributes to theory by increasing our understanding of how DevOps affects the firm. I achieve this by analyzing DevOps from its enabling factors to its impact on IT performance. I start by proposing an idealized DevOps profile and consider the degree of alignment between a real organization and that profile. Then I focus on four core factors of DevOps, (1) technology, (2) management and (3) culture, and (4) Delivery Approach. Finally, I consider DevOps outcomes and the impact on IT performance. These constructs and relationships are shown in Figure 1.

Figure 1. Research Model



## HYPOTHESES DEVELOPMENT

## The Ideal DevOps Profile and a DevOps Definition

While authors such as Jabbari et al. (2016) simply mention DevOps as the combination of Development and Operations, others treat DevOps as something far more complex. For this research, the definition of DevOps will be the following: DevOps is the synergy in software development between state-of-the-art technology, business and IT management and a generative culture in an organization level that seeks better performance in a response to a hyper dynamic market. Based on the information gathered in the DevOps literature, we propose what we call the ideal DevOps company. The ideal DevOps Company is nothing more than a possibly unreachable goal of a perfect DevOps company would behave like, as mentioned in the literature. This ideal company would be able to have developed and high functional technological and managerial factors, as a generative culture. This company would be highly developed in all these three different dimensions, which in turn would lead to a mature Delivery Approach Factor and thus be categorized as a mature DevOps company. We can use this ideal DevOps company as a goal in which existing companies can align, since the authors such as Kim et al. (2014) and Ravichandran et al. (2016) firmly defend the relationship between a developed DevOps company and firm performance (e.g., ROI).

## The Role of Technological Factors for DevOps

The technological factors for DevOps are automation and cloud computing. Nonetheless, DevOps differentiates itself from these practices by being more than just the sum of its parts, reflecting an evolution of these practices and convergence of these different approaches into one unique way of delivering software. The more of these factors in the company the greater the DevOps potential the company possesses (the closer the company is to the ideal DevOps profile). While these factors are not the only ones to be attached to DevOps, they are the ones more consistently cited in the DevOps literature.

### Automation

Discussing Automation in the DevOps context is one of the most important topics for most authors (Erich et al. 2014, Roche 2013). By adopting DevOps, the organization will be able to automate their processes with better success rate and in faster lead times. The easiest way to define automation tools is saying that "IT automation is responsible for the linking of disparate systems and software in such a way that they become self-acting or self-regulating". When the automation process is correctly done, it enables the IT department to focus on more important tasks instead of operational work.

### Cloud Computing

Cloud computing is a vital technological tool that suits DevOps well, as it enables faster communication and sharing between different departments. Jabbari et al. (2016) assert that Cloud Computing can be considered as an enabler for DevOps. Smeds et al. (2015) also argue DevOps is made better using cloud computing technological tools that facilitate continuous delivery, one of the main goals of DevOps.

While individually any of these Technological Factors can be found in the IT software development process, when applied together in a company, they will support the transformation into enablers for what is called DevOps. DevOps comes from the natural evolution of previously established concepts. The novelty involved comes from the unique combination of different methodologies and processes to form a new and improved way of developing software inside the company. It is by evolving on the previous breakthroughs from those technologies that DevOps truly reaches its potential. Using these available tools as presented by the literature, the following proposition is made:

*Hypothesis 1a: There is a positive relationship between Technological Factors and the Delivery Approach Factors.*

## The Role of Management Factors for DevOps

The Management Factors for DevOps come from a heritage that includes lean management and agile methodology. DevOps is an evolution of these practices as a form of adaptation into a more competitive and dynamic IT environment. The more mature the Management process in the company the greater the DevOps potential the company possesses (the closer the company is to the ideal DevOps profile). While these managerial methodologies are not the only ones to be attached to DevOps, they are the ones more consistently cited in the DevOps literature.

## Lean Management

Lean Management focus on flow more than anything else, bottlenecks in the process must be removed and wasteful activities need to be identified and avoided (Marschall 2012). As Arnheiter and Maleyeff (2005) explain, "Lean management is the achievement of high throughput and low inventories and the reduction of waste. By this elimination of waste, all activities along the value stream create value, and companies should strive for continuous improvement and seek to establish standardized work procedures." DevOps captures these ideas of focus on quality and synergy between different departments in the company, especially when it comes to indirect and overhead activities. DevOps means that they should be involved in all the steps to make sure the software will work properly from the inception to market (and during its life cycle).

## Agile Methodology

The Agile Methodology is the use of guiding principles known as the Agile Manifesto (available at: http://agilemanifesto.org/principles.html) that guide software development building upon lean concepts but adding concepts that apply for the IT development context. Agile Methodology claims lower costs, better productivity, better quality and better business satisfaction (Mishra and Mishra 2011), and it does so by focusing on individuals and interactions instead of processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation and responding to change instead of following a plan (Beck et al. 2001). Jabbari et al. (2016) proposes DevOps as an extension of the Agile Methodology. It is important to understand that DevOps, as expressed by Kim et al. (2014), is the outcome of applying more than a century of sound management practices to the IT value stream.

*Hypothesis 1b: There is a positive relationship between Management Factors and the Delivery Approach Factors.*

## The Role of Cultural Factors for DevOps

Organizations that carry a generative culture seems to handle information in a more productive way than pathological or bureaucratic ones (Westrum 2004). That affirmation goes together with DevOps authors that proposed that DevOps creates a culture of communication and collaboration (Erich et al. 2014) that reinforces this type of culture. Puppet Labs (2015) matches the characteristics of a generalist generative culture from Westrum's (2004) paper with the concepts of a DevOps culture. DevOps authors mostly agree on which kind of culture a DevOps company should have.

Leidner & Kayworth (2006) suggest that IT changes culture over time as IT-cultural conflicts arise and are resolved. They have suggested that the outcomes experienced in using a specific IT that initially conflicted with the user group's IT values will work to reorient IT values. As IT values become positive, groups are more likely to accept new IT, thereby reducing system conflict. The DevOps literature (see Erich et al. 2016) understand the importance of the cultural impact of DevOps changes to the organization and acknowledge that organizations with similar values to those embedded in DevOps will experience less conflict adopting DevOps. Also, when the organization perceives DevOps as something positive, they will make greater efforts to successfully adopt DevOps inside the organization. As culture cannot be ignored as an important factor regarding DevOps adoption, researchers such as Jabbari et al. (2016) mention the role of Culture in DevOps success. It is almost impossible to find any kind of research both academic as from the industry that does not point a communicative and collaborative culture as playing a role in DevOps adoption (Kim et al. 2014, Smeds et al. 2015).

There are several characteristics of culture shown in the literature as important for DevOps adoption (Smeds et al. 2015), such as shared goals, definitions of success, incentives; shared ways of working, responsibility, collective ownership; shared values, respect and trust; constant effortless communication; and continuous experimentation and learning. Westrum's (2004) proposition of what he calls a Generative Culture, in which the company shows the following characteristics: performance oriented; high cooperation; sharing of risks; bridging encouraged; novelty implemented. The definition of a DevOps culture resembles greatly what Westrum (2004) called a Generative Culture (as opposed to a Pathological or Bureaucratic culture). Thus, the following hypothesis is made:

*Hypothesis 1c: There is a positive relationship between organizations associated with Generative Culture values and the Delivery Approach Factors.*

### The Role of Delivery Approach Factors for DevOps

According to Kim et al. (2014), the competitive advantage that DevOps creates is enormous, enabling faster feature time to market, increased customer satisfaction and rates of deployment. Nonetheless, it is not clear if and how DevOps can lead to all those benefits. One of the goals of this research is determine if DevOps leads to increased performance. To do so, it is important to identify how the process of DevOps happens inside the organization. Delivery Approach Factors are the factors tightly linked to the how the DevOps process works.

Several authors such as Puppet Labs (2015), Erich et al. (2014), and Ravichandran et al. (2016) agree that some already stablished IS metrics are more than adequate to prove the impact of DevOps on the organization. The most discussed ones are, Rate of Deployment and Lead Time, Mean-time-to-Recovery (MTTR), Change Success Rate, Availability and Performance (Response Time). According to Kim et al. (2014), DevOps companies were outperforming other non-high performing peers in agility metrics such as 30x more frequent code deployments and 8,000x faster code deployment lead time, and in reliability metrics they were showing 2x the change success rate and 12x faster the MTTR (Mean Time to Repair). According to them, those organizations were more agile than their counterparts. Table 3 (Kim et al. 2014) shows the rate of deployment from some companies that use DevOps in comparison to the "typical" IT organization.

Table 1. DevOps companies compared to the typical enterprise. Adapted from Kim et al. (2014)

| Company | Deploy Frequency | Deploy Lead Time | Reliability | Customer Responsiveness |
|---|---|---|---|---|
| Amazon | 23,000 / day | minutes | high | high |
| Google | 5,500 / day | minutes | high | high |
| Netflix | 500 / day | minutes | high | high |
| Facebook | 1 / day | hours | high | high |
| Twitter | 3 / week | hours | high | high |
| Typical Enterprise | once every 9 months | months or quarters | low / medium | low / medium |

DevOps indicators are the visible outcomes of a successful DevOps adoption. All these indicators were a part of IT success measures previously, however, in the DevOps context, these indicators show values that were not previously seen in any kind of technology organization. These indicators are the most reliable way of showing a successful DevOps implementation in a company. Because DevOps focus on communication, a collaborative culture, and focusing on solutions instead of finding people to blame, indicators like these will show how much the company resembles the ideal DevOps profile, as their time to respond to any kind of problem and fixing it will become shorter (Riungu-Kalliosaari 2016). Not only when they deploy changes and code, they are more likely to be completed successfully (i.e., without causing a production outage or service impairment), but when the change failed and resulted in an incident, the time required to resolve the incident was faster (Kim et al. 2014). Since DevOps has several different stages of adoption, for this research an organization that proclaims itself to be a "DevOps Organization" will be considered one, even though some might not adopt DevOps fully. Thus, the following proposition is made:

*Hypothesis 2: There is a positive relationship between Delivery Approach Factors and favorable measurable IT Outcomes.*

## METHODOLOGY

The research model will be validated by a survey of IT managers. IT managers are considered the ideal population since they serve as proxy of the organization, meaning that their opinion reflects the organization's opinion on the subject. Also, they possess knowledge on the steps of DevOps implementation in the company. Structural Equation Modeling (SEM) will be used to measure the research model. The statistical tool for analysis will be R. A pilot survey will be used with sample gathered from Amazon Mechanical Turk. The goal of the pilot study is to evaluate content validity and do a confirmatory factor analysis, as most of the questions on this study were developed exclusively for this research, based on previous literature. A 7 point bipolar likert-scale will be used for the survey.