PEDRO GOMES BRANQUINHO

Free software in industry and academia

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University of São Paulo - USP
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Monograph, Conclusion Thesis

Supervisor: Dr. Wei-Liang Qian

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To those whom found me in their own path
and, by finding me, made part of my own.

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Abstract

In this work, It's shown how to build a series of application only upon a Free Software system - EXWM, Artix Linux OSS. I explain how the experience of participating in the Open Community can be significant for other Engineers; specially Physics Engineers. It's delineated what are the current trends on the adoption of Free and/or Open Source Software (FOSS). Furthermore, I put forward some of the tools I used in Academia, and in Industry, and some other not so well known software, which could be used in these two contexts - e.g., Freqtrade, OR-Tools, Git(hub) et cetera. I also argue why Linux is such a key software for someone shifting to the Open Source paradigm.

Key-words: trends. foss. academia. industry. linux. freqtrade. or-tools. git. github.

Resumo

Demonstrou-se como é possível construir uma série de aplicações baseada em softwares de licença livre, à partir de um sistema aberto, o Linux com inteface EXWM - Emacs X Window Manager. Além disso, foi propiciado casos reais de aplicações na Indústria e no investimento privado, autônomo. Bem como, utilizações na Academia, à nível de lecionar, e pequisa. Sustenta-se que a economia aberta possui similaridade estrutural ao movimento *Open Source* e seu desenvolvimento, o que aponta que essa é e continuará a ser, paulatinamente mais, o paradigma de desenvolvimento econômico tecnológico. Assim, imprescindível à formação do engenheiro.

Palavras-chaves: software livre. automação. freqtrade. idústria. academia.

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List of abbreviations and acronyms

FOSS	Free and Open Source Software
IDE	:Integrated Development System
abnTeX	ABsurdas Normas para TeX

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1 Introduction

In training a Physics Engineer, of which, by definition, is a generalist professional. The use of Free and Open Sourced Softwares (FOSS), as well as the participation in the Open Source community (OS), are two detrimental experiences to have.

The variability, which open source software (OSS) brings to existence of applications and it's extension, can change altogether user's experience. Thus, taking him closer to acting as a developer. This experience of interloping user and developer roles doesn't require that you are a computer scientist or a Information Technology (IT) professional by training. For, programming can be seen as both a Science and an Art (KNUTH, 1968) - e.g., an exercise of self-expression.

OSS guarantees four fundamental liberties section 2.1, the right to study, copy, modify and redistribute it.

Just as the scientific enterprise benefits, with it's rapid development, by means of the global community's participation, which holds space for individuals with a variety of different training. Also, the computation enterprise benefits from the variety of people's training, which constitute the body of the open source community.

1.1 Objective

We will demonstrate the vality of the hypothesis that a engineer professional, without strong training in computation, lags behind it's current potential. Furthermore, we present a range of different applications developed to the state of the art, which are distributed under open licenses (copy-left). Thus, reinforcing the uniqueness of open source phenomena and the need for it's use - the logic and dynamic FOSS brings has no parallel on the economy or scientific community (HIPPEL; KROGH, 2003; PETERS, 2009).

There exits debate around the meaning of *Open Science*. This term recently became popular and which has a obvious reference to the *Open Source*. Although, in the social literature, it's a phenomena poorly depicted and rarely debated through the point view that the Open Source Movement has anything to do with it. We cite the most cited article on Google Scholar research on the topic "Open Science" - called "The future(s) of open science" - and which only uses trice the term "Open Source" and in dismissive way (MIROWSKI, 2018).

Therefore, I argue that a strong basic knowledge, for engineer training, is fundamental for understanding the movement and how it has been shaped, so to critically asses the validity of the current social-economic shift we live in. This understand can, in turn, shape

the carer path and formation of the working engineer.

1.2 The interconnection between Applications and the OS

The author used an **Application** as to comprise any end product of software development.

1.2.1 Why does GNU/Linux matter?

We will discuss, as a brief introduction, what is the Operational System (OS) GNU/Linux, and why it's the *de facto* opening door to the Open Source Community. Firstly, the GNU/Linux is the first and most successful project carried out in the Open Source paradigm (TU et al., 2000; WEST; DEDRICK, 2001). Therefore, it's use is a way to acquaintance, in practical terms, with how a business dependent on mainly using the open sourced development products might operate (FINK, 2003).

Furthermore, the new user-developer of the GNU/Linux framework must inherently learn about the accompanying software which comes with it's distribution - which increases it's chance of adoption (WEST; DEDRICK, 2001). This way, the user gradually becomes accostumed to participate on development and extend programs (HERTEL; NIEDNER; HERRMANN, 2003).

Beyond it's initial philosophical appeal to user liberty, GNU/Linux is today's standard in Technological Enterprises. And, although fundamentally opposed of many age-old *modus operandus* of the *status quo* of companies, there is no doubt left under analysis of the benefits it brings to the companies, general economy, and the society triad (MOODY, 2009). To make use of GNU/Linux, thus, is a way to be inserted in this new economic paradigm (HIPPEL; KROGH, 2003; PETERS, 2009).

1.2.2 How high level applications benefit from an OS

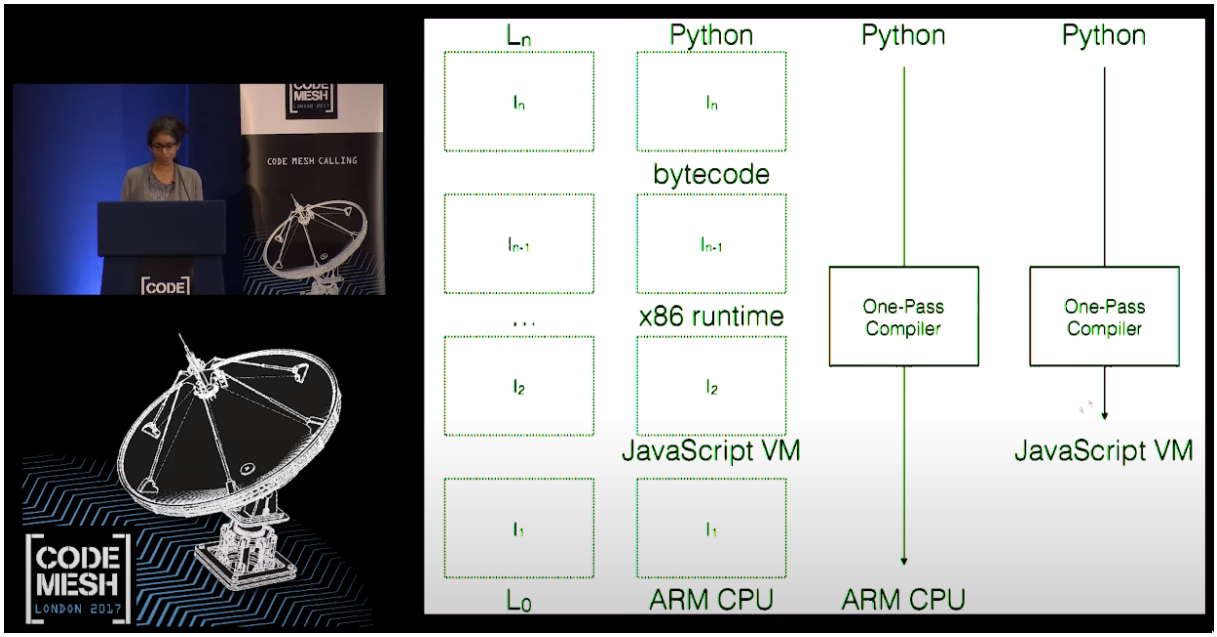
In the hierarchy of software and applications, the Operational Systems (OSes) can be seen as a meta-application or meta-software.

"The evaluator, which determines the meaning of expressions in a programming language, is just another program." (ABELSON; SUSSMAN, 1996)

There exists levels, or layers, of abstractions in virtually any application. That is, the concept of meta-programming and Towers of Interpreters comprise a common situation, for which a devoted field of study exists. Thus this area has direct implication for software development practice, as it's a ubiquitous problem faced in computing.

Any OS, as the GNU/Linux, comprise an essential layer in this tower of interpreters. Particularly, an OS communicates with *firmwares* - low-expressivity and highly-performing software, which control *hardware*. Also, they communicate with high-expressivity software, among which contain the user-developer written or extended software. Therefore, the OS play a fundamental role, mediating between low and high level software. This function categorizes them as a *middleware* software.

Figure 1 – Schema of a tower of interpreters



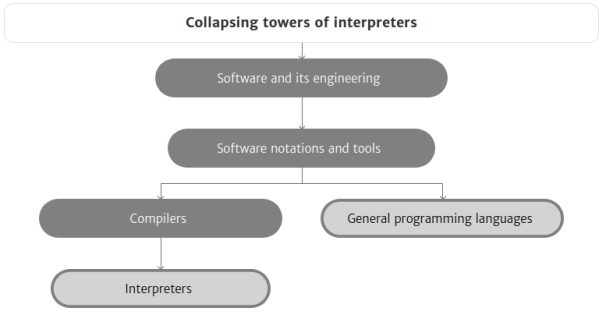
Code Mesh, presentation “Towers of Interpreters”, by Nada Amin

The characteristic problem of concatenate a system of software, one on top of the other, introduces complexity to maintaining compatibility among program's versions and it's performance. The study of these behavior and it's theoretical solutions posses a field of it's own. And, this field is autonomous, detached, for an example, from which languages compose the Tower of Interpreters; or which type of application we are dealing with (AMIN; ROMPF, 2017). The object of study is the final behavior of the system, and if it's a collapsible system.

Finally, the OSes consist in a big tower-collapser of interpreters. They are subordinate to collapsing firmware, middleware and high-level software. Therefore, as well as the OS conduct this task, as much the user-developer experience is facilitated.

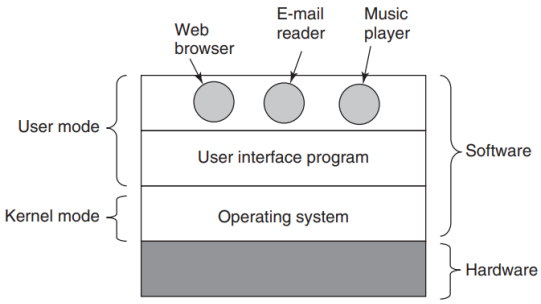
> If every application programmer had to understand how all these things work in detail, no code would ever get written. Furthermore, managing all these components and using them optimally is an exceedingly challenging job. For this reason, computers are equipped with a layer of software called the operating system, whose job is to provide user programs with a better, simpler, cleaner, model of the computer and

Figure 2 – Categorization of the study of towers of interpreters



Reference: (AMIN; ROMPF, 2017)

Figure 3 – Towers of interpreters and the Operational Systems.



Reference: (TANENBAUM; BOS, 2015)

to handle managing all the resources just mentioned. (TANENBAUM; BOS, 2015)

1.3 On the influence of education in adoption

In the bibliographical literature, it's clear that the rate of OSS adoption in the Industrial sector - commonly refereed as"Production" - depends heavily on both: competency and the level of expertise a project require (LI; TAN; YANG, 2013; GALLEGO et al., 2015; SPINELLIS; GIANNIKAS, 2012).

At the same time, the adoption depends directly on the intrinsic inclination of the Informational Technology (IT) team (RACERO; BUENO; GALLEGO, 2021).

Therefore, regardless of how much a professionalizing course may increase the intencity and quickness of adoption. Data shows that, generally, those students and professionals positively correlated to seeking autonomy would adopt it (RACERO; BUENO; GALLEGO, 2020). This means that intrinsic motivation is key (GALLEGO et al., 2015). Nonetheless, it's important to notice that there exist a net-effect in adoption (SPINELLIS; GIANNIKAS, 2012). e.g., how much more peers adopt it, the more likely to any given

individual to adopt it.

1.4 Performance and the current trend as reasons for adoption

Research with different areas of benchmarks state a performance gain, when utilizing GNU/Linux, compared to Windows (SULAIMAN; RAFFI, 2021). Although, even more important, the key benefits are not in the differential performance per se, but in the training one naturally goes through upon utilizing a totally community-dependent Operational System.

Thereof, using GNU/Linux is a door for an individual professional shift. At the same time, this personal use increases the probability of adoption in whichever Industry carrer one may lead (HAUGE; SØRENSEN; CONRADI, 2008). Combined with that fact, the Industry per se has no observable effect on Open Source development of projects - as so far as measured in 2008 (HAUGE; SØRENSEN; CONRADI, 2008).

1.5 The set-conjunction between physics engineer and FOSS's users

We note that the deepness of training proposed, in graduation level, for a physics engineer makes them perfect candidates for the use of FOSS. Because, both trainings imply a *a priori* necessity for autonomy and purposeness (SCHRAPE, 2019; RACERO; BUENO; GALLEGO, 2020); imply a profound and will for generalistic technical knowledge (LI; TAN; YANG, 2013; GALLEGO et al., 2015).

1.6 How to leverage the potencial of OSS in Industry and Academia

In the present work, I utilized of many concept demonstrations, in which the autor has developed or/and extended applications, in a context of free and open source. Also, I present how can one collaborate in the community and how does that collaboration can imply significant professional connections. This way, both the so called "soft skills" and "hard skills" benefits have been elucidated, in practice.

2 Bibliography review

2.1 Open Source

Any program which permits the user-developer to have the following liberties:

1. The right to run the program, as seen fit, for any end.
2. The right to access the source code and study it.
3. The right to copy and redistribute it.
4. The right to modify the software.

Practically, the Open Source community fundamentally base itself upon the free distribution of it's tools and programs. One of the differential advantage of having innumerable other people extending the same software is that the advancement of the frontier of the program, in many directions, increases rapidly in relation to a program controlled by a limited number of programmers.

2.1.1 Diversity

Given that one fundamental right of OSS is the modification and propagation of new modified versions. This right implies in the observable wide range of maintained versions of these software, which doesn't have a parallel in any other technological enterprise.

For an example, one key application in any user's computer is a general Graphical User Interface (GUI)'s manager, commonly known as Window Manager (WM). These can be both Floating or Tilling, or mixed WM, e.g., Floating WM are those that the user must hover windows and adjust them manually; Tilling WM are those that a pre-defined program have a set of rules to resize automatically the windows in a screen.

While private Operational Systems (OS), as Windows and MacOS, have frequent releases - a total of twenty five releases for Windows. Generally, they've few *active* versions; Windows have currently four (MICROSOFT..., 2021). MacOS also have four active versions (MACOS..., 2021).

The fact there are only narrowly supported versions is due to, among many contributing factors, users lack the right to alter and extend the software's behavior. Therefore, they fall victims of discontinued support and restrictive access to the company's official upgrades.

On the other hand, there exists, in parallel, around two hundred seventy eight available distributions of Linux (LINUX..., 2021). Of which, there are main/root distributions, which each embody a set of different principles; theoretical and practical philosophies of

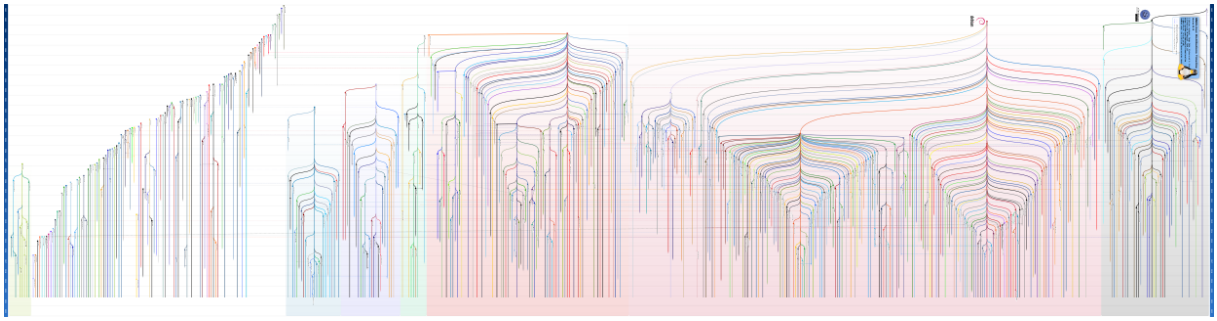
how to extend software.

Thus, just as with any other scope of software, the variability of FOSS always will be grater than monopolized ones.

2.2 GNU/Linux

There are root distributions of Linux, from which many other distributions emanate. Generically, these partitions are called families. We cite some of the most influential and popular ones, Red Hat Linux (), Debian (), CentOS (), Fedora(), Pacman-based (/), OpenSUSE (), Gentoo-based (), Ubuntu-based(), Slackware (), Open Sourced-based and the Independent Distributions (/).

Figure 4 – Genealogy of Linux's Distributions



Genealogical history of Linux Distributions (LINUX..., 2021)

2.2.1 Historical Origin

The GNU/Linux began as two separeted and different directions. GNU stands for "GNU's Not Unix", a recursive name. And GNU initialy has been developed as a collaboration of revolted academics by the restrictive secure system of the MIT Lab (Laboratory of Compuer Science - LCS) (STALLMAN, 2002; EMACS..., 2021). Amongst them, there was the still active Richard Stallman, which heavily worked on the text editor of the time - already ten years into development. This editor became Emacs (EMACS..., 2021).

Parallel to these events, Linus Torvalds had been developing an open portatible operational system, as his master's thesis (TORVALDS, 1997).

Finally, both projects united in a symbiotic system, of which the OS was Linux (the formentined portible kernel) and the GNU's interface program whit all utilities one may have had in their computers at the time (STALLMAN, 1997)

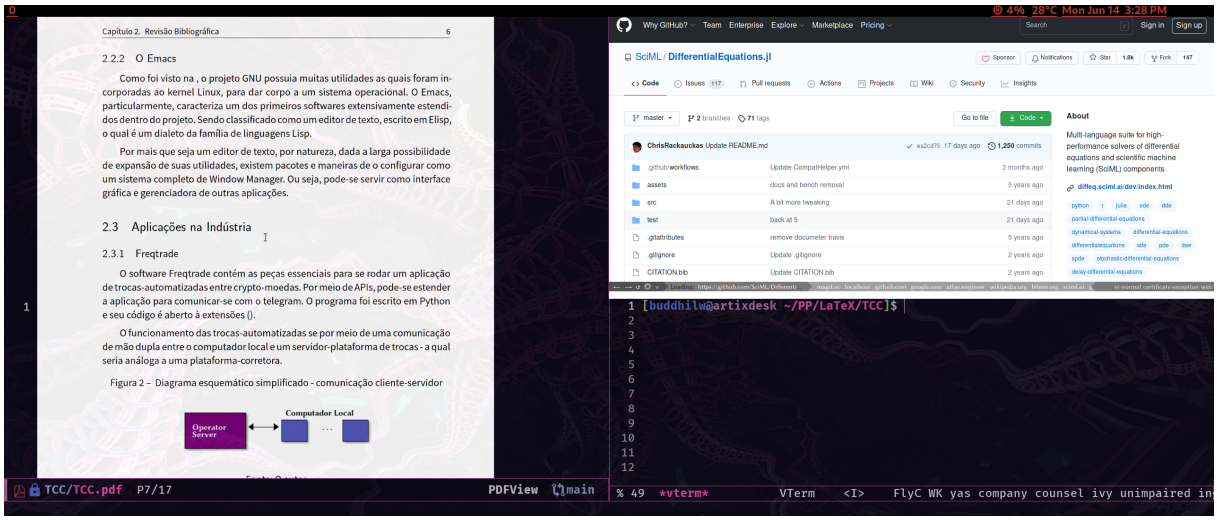
2.2.2 Emacs

As has been seen in , the GNU project already had developed a variety of applications, all of which, incorporated into Linux. This way, the OS gained a "body". The Emacs, particularly, characterize one of the first software extensively extended, as a project, in a open community.

Although, the label given to Emacs as an "editor" covers it's main function. Actually, the fundamental role of Emacs equates to evaluating Elisp expressions. Elisp as in a dialect of Lisp. Therefore, as an interpreter of a language, it has Turing complete capabilities. So it has a complete-system capability [1].

Even though Emacs usual use has been of an Integrated Development System (IDE), by it's unlimited potentiality and expressiveness, there exists packages and applications written in Elisp to become a fully featured Window Manager (WM). That is, Emacs, through Emacs's X Window Manager (EXWM), can serve as a graphical and manager interface to other applications.

Figure 5 – EXWM - Emacs X Window Manager



Source: author's WM ambient.

Figure 5 exemplifies a desktop environment which can render images, PDFs, Browsers et el, through Emacs.

[1] The GNU/Guix implementation of Linux, has been implemented in Scheme - a cousin with better performance than Elisp

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2.3 Comparações entre a performance e adoção de sistemas operacionais

2.3.1 Performance

Quando testado em termos de eficiência, o Windows 10 performa-se bem abaixo do Linux, em tarefas em nível de usuário (SULAIMAN; RAFFI, 2021).

Em um mesmo hardware, os programas que são executados no pano de fundo, continuamente, pelo Windows consumem um valor próximo de 5% de CPU e 41% de RAM. Enquanto, no Linux Mint - uma versão popular de Linux - o consumo é de 1.8% de CPU e 24% de RAM. Uma diferença de performance de mais de mais de 200% em CPU e aproximatamente 200% em RAM (SULAIMAN; RAFFI, 2021).

A execução de um programa escrito em VBS - relacionado aos programas do pacote Office -, se dá com uma diferença de 0.501 segundos para o Linux Mint e 4.75 segundos no Windows. E.g., existe uma diferença absoluta de $\frac{4.75-0.501}{0.501} = 423\%$ em performance (SULAIMAN; RAFFI, 2021).

Por fim, também existem pesquisas feitas com rigor técnico em todas as outras área de manuseação de *firmwares/harwares*, como *wireless* (**??**); paralelismo e manuseação de aplicações em servidores (**??**); programas científicos (Fast Fourier Transform) et al (**??**); performance em arquiteturas de Realidade Virtuais (VR) (**??**) etc. Todas elas demonstram uma performance superior na renderização e/ou no tempo de renderização em plataformas GNU/Linux (**??????**SULAIMAN; RAFFI, 2021; **??**).

2.3.2 Demografia da adoção de FOSS

Fritzgerald enunciou em 2006 que o perfil de adoção dos sistemas open source estava numa fase "OSS 2.0", o qual transcendera a generalização de que isso era algo inutilizável pela pessoa média e uma ferramenta exclusiva de "*hackers*" (**??**). E, que ainda haveriam conseguintes transformações até um patamar *mainstream*. Isto é, se tornaria um lugar comum na sociedade e industria, e que grande parte do desenvolvimento seria de autoria de grandes empresas.

Em 2008, foi feita uma pesquisa sobre a adoção da indústria de softwares, na Finlândia. Em contraste à caracterização de Fritzgerald, 50% das empresas utilizavam amplamente de Open Source Software, porém, a participação era quase nula na comunidade aberta. Por fim, mais de 30% dessas empresas participantes relatavam que 40% do ganho era fruto de produtos e serviços desenvolvidos pela comunidade aberta(HAUGE; SØRENSEN; CONRADI, 2008). É importante se notar que eram empresas de pequeno e médio porte, em sua maioria.

Em 2012, um estudo em grande empresas - mil companias listadas na revista US Fortune - derivou algumas conclusões (SPINELLIS; GIANNIKAS, 2012):

- A adoção está diretamente associada à equipes de TI com trabalhos os quais demandam expertise e conhecimentos extensivos especializados, bem como busca por eficiência (GALLEGO et al., 2015; LI; TAN; YANG, 2013).
- Aumento exponencial, à partir de um ponto de acumulação;
- Existe um efeito-rede responsável pela adoção nas grandes. empresas;

Assim, a adoção em empresas de pequeno, médio e grande porte variam grandemente, e não possuem efeitos notáveis na expansão do movimento. No entanto, ainda são positivamente influenciadas por ele (SPINELLIS; GIANNIKAS, 2012; HAUGE; SØRENSEN; CONRADI, 2008; **??**). A maior influência positiva no movimento, indica-se, é dado por pequenas empresas (**??**).

Observa-se no entando, de 2012 ao presente, uma intensificação de adoção e ubiquidade da adoção dessas tecnologias abertas (**??**). São consideradas, atualmente, o berço inovatório da indústria de softwares (SCHRAPE, 2019; **??**).

Pesquisas mais recentes determinam que, independente do tamanho da empresa, a adoção da empresa depende diretamente do treinamento dos agentes de TI e sua inclinação por autonomia (RACERO; BUENO; GALLEGO, 2020). Finalmente, a adoção e crença na efetividade desses softwares depende de fatores principalmente intrínsecos e independem de treinamento, por mais que os treinamentos em OSS potencializa a adoção de usuários inclinados ao uso (RACERO; BUENO; GALLEGO, 2021).