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Tarumanagara International Conference on the Applications of Technology and Engineering 2018

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Paper Title: Product design of chairless chair based on local components to provide support for active workers

November 22nd - 23rd, 2018 | Universitas Tarumanagara, Jakarta

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Tarumanagara International Conference on the Applications of Technology and Engineering will be held in Campus I, Universitas Tarumanagara, Jakarta, Indonesia on November 22nd - 23rd, 2018.

Full Paper Submission Deadline	October 17th, 2018
Acceptance Notification	October 24th, 2018
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Submitted conference papers will be reviewed by technical committees of the Conference. Completed papers (PDF format) should be submitted to **easychair system** or by email **ticate@untar.ac.id** before the deadeline.

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We look forward to receiving your papers and to welcoming you to the TICATE 2018, Universitas Tarumanagara, Jakarta, Indonesia .

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1st Tarumanagara International Conference on the Applications of Technology and Engineering 2018

Preface

On behalf of the organising committee of 1st Tarumanagara International Conference on the Applications of Technology and Engineering (TICATE) 2018, I would like to welcome all delegates to the Campus of Universitas Tarumanagara (UNTAR) in Jakarta, Indonesia with great pleasure. Being held from November 22 to 23, 2018 the international conference is organized by UNTAR and technically sponsored by IOP Conference Series: Materials Science and Engineering (MSE).

Universities play an important role in facing the rapid development of technology and engineering in recent digital era. The rapid developments of technology and engineering impact various aspects of people's life in welcoming the era of Industry 4.0. The biggest challenge faced by universities due to these rapid developments is how the results of research and technological innovation can contribute to the people's prosperity. As a form of contribution from universities in responding this challenge, Universitas Tarumanagara hold the 1st TICATE 2018 with the theme of: "The Implementation of Research Results and Innovation for People's Prosperity".

This international conference activity is expected to be a forum of discussion, networking and exchanging ideas among researchers, academicians, and practitioners to work together to pursue research and technological innovation that can be used to contribute to people's prosperity.

Over 160 papers have been submitted to 1st TICATE 2018 from 6 different countries, those are Germany, France, Australia, Taiwan, Malaysia, and Indonesia. We categorized the papers under seven groups, namely Mechanical Engineering and Technology; Electrical Engineering; Industrial Engineering; Civil and Environmental Engineering; Food and Agriculture Technology; Informatic Engineering & Technologies; and Medical & Health Technology. All papers, regardless of their standing or initial classification, were available for general discussion at the committee's meeting.

Our special thank goes to our Rector, Prof. Dr. Agustinus Purna Irawan, who has initiated this conference, Dr. Svann Langguth as Head of Science and Technology Division from the Embassy of the Federal Republic of Germany in Jakarta, Prof. Dr. Mohd. Zulkifly bin Abdullah as Professor from Universiti Sains Malaysia, and Dr. Ir. Yono Reksoprodjo, DIC as Vice President Corporate Affairs of Sintesa Group, as our pleanary speakers and Bank DKI, Bank Mandiri, Tarzan Photo, Hyperzone Computer, as our patrons. I would like to give special thanks to all of you for the interesting keynote speech at this international conference.

We also thank all individuals and organisations such as the members of international editorial board, the conference organisers, the reviewers, and the authors, for their contribution in making TICATE 2018 as a successful international conference and a memorable gathering event. I am also grateful for the support of publication service of IOP Conference Series: Materials Science and Engineering (MSE).

We hope that the conference could present you wonderful memories to bring home in addition to new insights and friendship congregated during the event. We truly value your participation and support for the conference. We hope that you will enjoy TICATE 2018 and Betawi culture and tradition in Jakarta.

Dr. Hugeng, S.T., M.T. (SMIEEE)

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Product design of chairless chair based on local components to provide support for active workers

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Product design of chairless chair based on local components to provide support for active workers

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Abstract. One problem faced by active workers is limited seating facilities especially in public transportation where they have to stand as they are carrying out their activities for long periods of time. In industry, the limited work area makes it impossible for operators to use seats, so operators have to stand for long periods when operating the machine. This study aims to design a chairless chair by utilizing local components that are cheap and easy to obtain in the market. The chairless chair product design uses the VDI 2221 method, while analysis of the strength of the chairless chair structure uses Autodesk Inventor 2017 software. In this design, several design variants have been made which are then compared by assessing their volume, mass, production costs and comfort levels, so that the best design variants for prototyping are obtained. Based on the results of the research, a comfortable, safe to use chairless chair was produced with local components. The results of this study become a reference for further development.

1. Introduction

In industrial work, many workers do the same activities to produce a product produced by the industry. Workers only get a break for a limited time. The workers mostly do their work by standing which results in fatigue, especially in their legs. If this situation persists, workers are not able to carry out their activities properly. This condition will reduce productivity in work [1], [2], [3]. One of method to reduce fatigue in working while standing is to design a chairless chair. The design of the chairless chair can reduce workload and tiredness while working. Chairless chair helps workers by supporting the body while working or makes the body less burdened without disturbing work activities. The reference in designing chairless chairs is a product that has been developed by the company Noonee and the Siddharth et al team. Noonee made the chairless chair frame of aluminium material with a weight of 1 kg each leg and used quick strapping to tie the frame to the user's feet. In addition, Noonee uses the electro switch or auto assistive as the controller of the suspension with a battery power source of 9 V with usage time of 8 h. The maximum load from the chairless chair made by Noonee is 100 kg per leg [4], [5], [6].

This study aims to produce a chairless chair design that is suitable for its users, by utilizing local components from Indonesia. The chairless chair is designed to reduce the load or feeling

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of fatigue during work. The worker's weight is supported by the chairless chair in a half-seated and half-standing position. This design will help workers to reduce fatigue due to standing for a long time to work. The design includes kinematics and dynamics analysis, analysis of the strength of the chairless chair structure and product prototype [7], [8], [9].

Figure 1. The chairless chair of Noonee [4], [5]

Figure 2. The chairless chair of Siddharth et al [6]

2. Method and materials

The research method and chairless chair product design refers to the VDI 2221 method. The design work steps are as follows: [10], [11], [12].

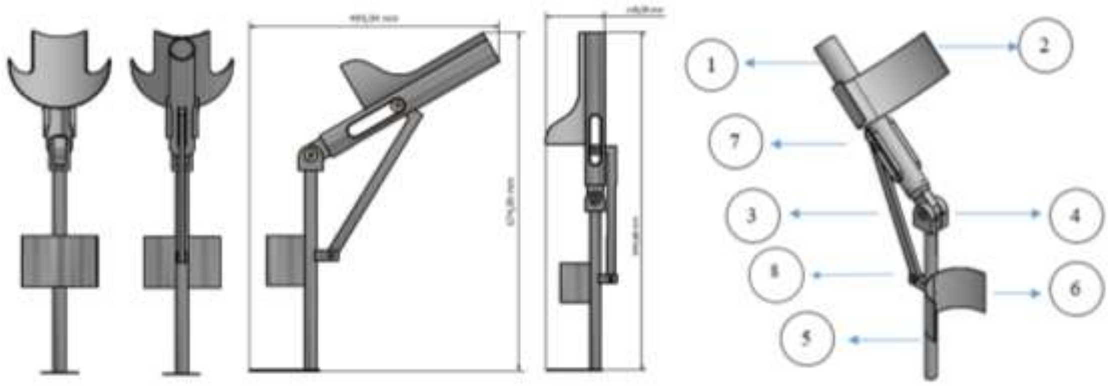
a. Clarification of the Task. This stage includes collecting information or data about the conditions that will be fulfilled by the design of the tool and also its limitations. The results of this stage are terms or specifications.
b. Conceptual Design. This stage includes information on the structure of the search function, the principles of problem solving that are suitable and combine into a variant concept. The results of this stage are basic problem solving or concepts.
c. Embodiment Design. This stage includes a sketch of a combination of principle solutions that have been made in the form of an initial layout. The principal solutions that meet the requirements that are in accordance with the specifications and are good according to technical and economic criteria are selected. The initial layout that is chosen and developed into a definitive layout is a form of design that suits user’s needs and expectations. The definitive layout includes several things that are the results of this stage, including the form of a product element and the selection of the shape and size of the component.
d. Design Details. This stage produces a product document design, so it can be produced continuously with better product development. This product document can include: design concept drawings, detailed drawings, operating systems and standard component selection.
e. Kinematics analysis of the chairless chair to ensure the movements of each component can be known when used.

f. Strength analysis of components by using computer software.
g. Creation and testing of the chairless chair product prototypes, so that the real usage testing can be carried out.

3. Results and discussion

3.1. Final design of the chairless chair

The maximum load that can be received by the chairless chair is limited to 100 kg, referring to the worker's weight. The size of the chairless chair will be adjusted according to the size of the person's leg. The length of the chairless chair in the calf part of the leg is 430 mm with a diameter of 25 mm, while in the thigh part, the length is 420 mm with a diameter of 50 mm. The slope when sitting is 30^o from a vertical position. Some considerations for the selection of materials used to make chairless chairs are lightweight, strong, corrosion-resistant, easy to obtain, easy to be produced into chairless chairs, and not too expensive. The chosen material is mild steel which is easily obtained in the local market of Jakarta. The chairless chair is made of mild steel with a thickness of 2 mm. The chairless chair is designed using a buffer that is different from the chairless chair that has been made by Noonee [4], [5] and Siddharth et al [6]. Buffers are used using a rod with a square cross section, with one end mounted on the calf and the other end placed on the thigh. The support on the shaft of the calf uses a pin and can move rotating, while on the thigh rod, the support is made of a rail that is useful for the running of the bearing. The end of the stand is mounted to two pads the right and left and the bearing is placed on the existing rail. The working mechanism of the chairless chair is the movement of pads on the rail when the chairless chair is used to sit. The bearing size used has an outer diameter of 26 mm, an inner diameter of 10 mm and a thickness of 7 mm. The types of bearings available on the market with these dimensions are 6000ZZ. The next stage is to design the concept with the help of software Inventor 2017. The final design of the chairless chair is in the following Figure 3.



1. Thigh section, 2. thigh section support, 3. support section, 4. joint, 5. leg section, 6. leg support, 7. support of section mechanism, 8. joint of support section

Figure 3. Final design of the chairless chair [7], [8], [9]

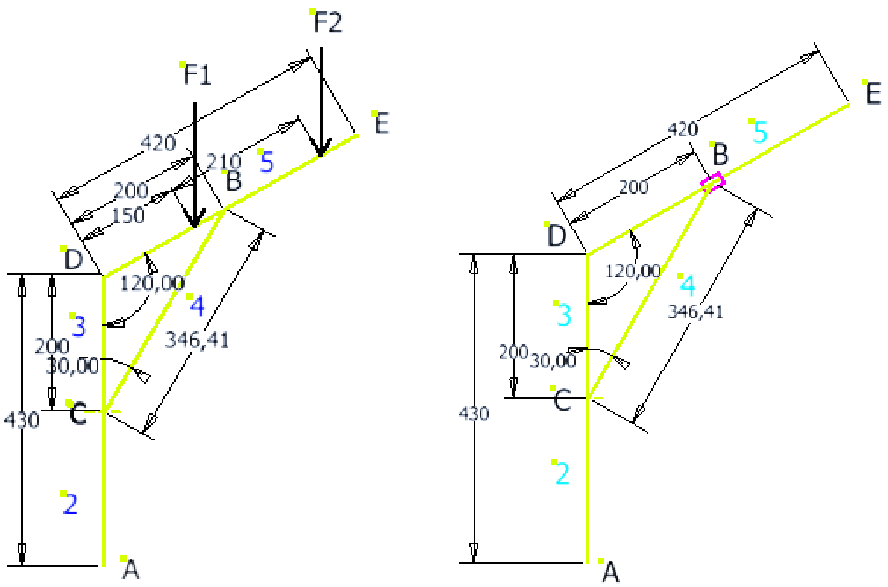
Table 1. Specification of the chairless chair

Specification	Unit
Material of frame	Mild Steel
Diameter of the upper frame pipe	50 mm
Diameter of the lower frame pipe	25 mm
Length of the lower frame	430 mm

Length of the upper frame	420 mm
Type of pipe	Silinder hollow
Pipe thickness	2 mm
Diameter of section pin	10 mm
Maximum load	1000 N
Leg binding method	Click Belt
Chairless chair weight	3.7 kg
Buckling angle maximum	120°
Straight angle maximum	180°
High when sitting	674.09 mm
High when standing	849.60 mm
Width when sitting	499.04 mm
Width when standing	148.09 mm

The chairless chair is operated by using a slider system in the buffer section. The frame is fitted with a bearing that is useful for sliding on the rail in the thigh support bar. When the user is seated, the support section will slide on the rail until it stops because it is stuck at the end of the rail. When the user is in standing position, the bearing moves freely on the slide rail.

3.2. Load simulation of the chairless chair



Scale 1:100 mm

Figure 4. Load system of the chairless chair [7], [8], [9]

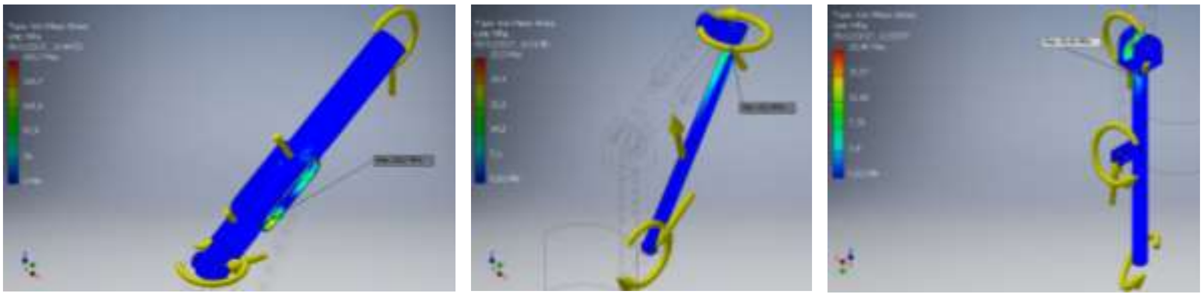


Figure 5. Load simulation of the chairless chair [7], [8], [9]

When giving a load to the chairless chair, the thigh shaft will receive the largest load on the thigh rod rail with a value of 169.7 MPa. It means that it is necessary to pay attention to this section. At the time of loading on the chairless chair, the supporting rod section will receive the largest load on the buffer pin hole with a value of 35.5 MPa, so that it needs to be considered in the manufacturing of product prototypes. At the time of loading, the support rod will receive the largest load on the placement of the thigh and calf stem pin with a value of 19.5 MPa, so it is necessary to pay attention to this section in the manufacturing of product prototypes.

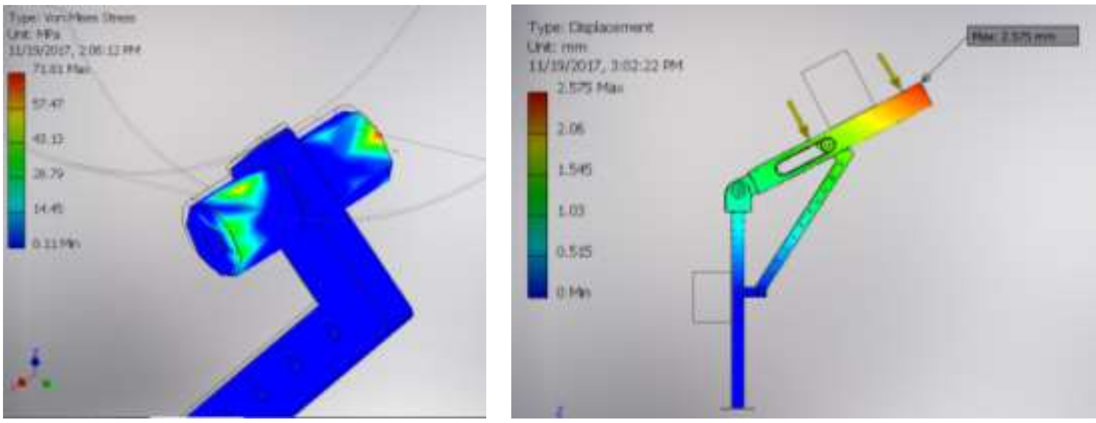


Figure 6. Stress and deflection analysis of the chairless chair

On the main pin, the rod part is designed with a safety factor of 2, the stress is obtained at 71.81 MPa. The deflection in the most critical area of the load is the thigh position of 2.57 mm, and the upper frame connecting part, the deflection that occurs is 1.03 mm, and the support section and support rail have a deflection of 1.54 mm.

3.3. Field testing of the chairless chair prototype

Figure 7. Field testing of the chairless chair [7], [8], [9]

Based on the results of field testing of the chairless chair product prototype, the following results are obtained: the chairless chair is very strong to be used for sitting because the deflection is very small; the chairless chair can reduce the load received by the thigh when sitting, the chairless chair's balance is still not good because when it is used for sitting, the user can still fall back [13]. Due to this, the foot step needs to be added longer therefore the balance of the chairless chair is better; chairless chair size is suitable for use in the operation of machines such as CNC machines in laboratories at Universitas Tarumanagara.

4. Conclusion

The research and design have been carried out to make chairless chairs that are used to reduce fatigue due to continuous work. Based on the results of the design, a chairless chair product prototype was created using local Indonesian components. The utilization of local components and products will have a positive impact on the development of Indonesia's national industry [13], [14], [15]. The chairless chair product has been tested and can function properly. Some of the weaknesses of the chairless chair product prototype produced, which is the weight of the chairless chair that is too heavy, causes the user not to be able to walk normally and can only walk slowly. Foot step addition in the leg section which is a fixed joint causes the user's leg to become stiff because the leg cannot move freely. This result is a reference for the development of chairless chair products that are more suitable for workers in Indonesia, especially those relating to the weight of the chairless chair, flexibility to move, safety, comfort in its use and low production costs.

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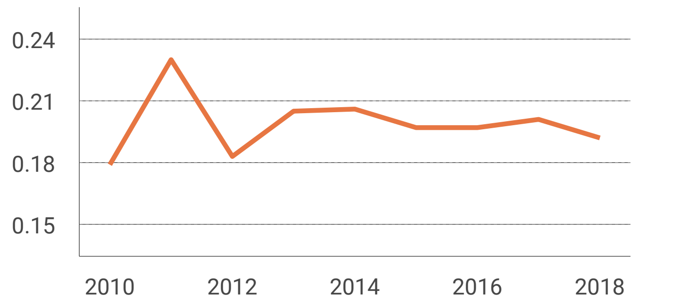

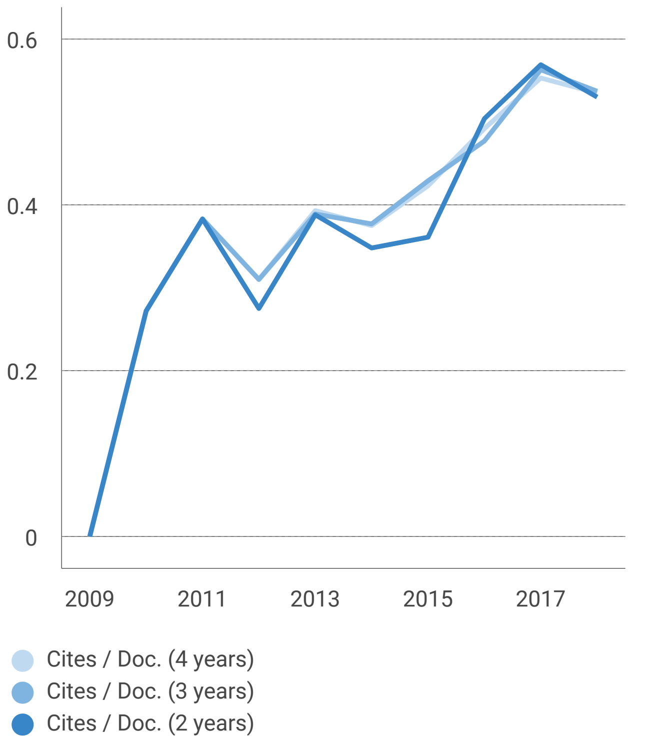

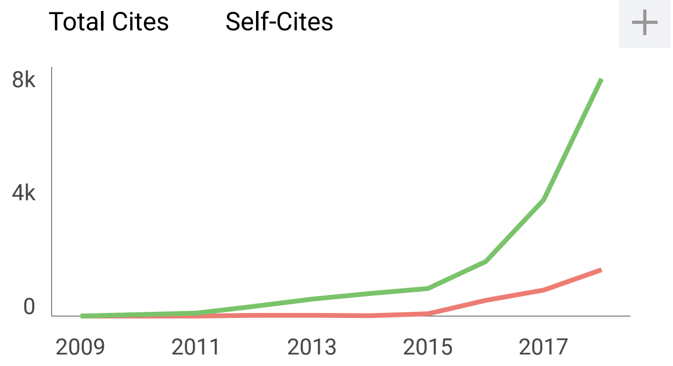

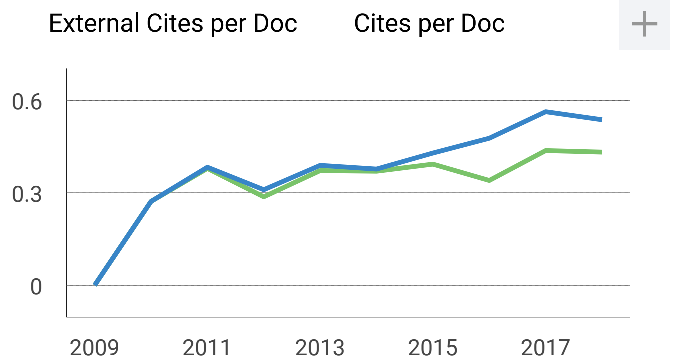

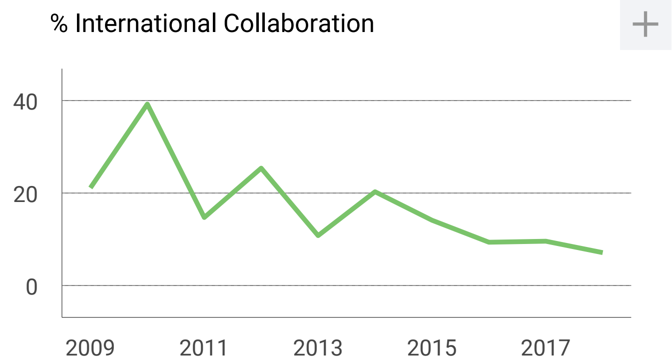

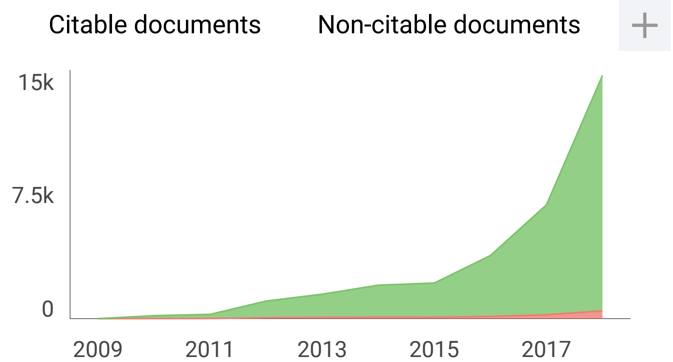

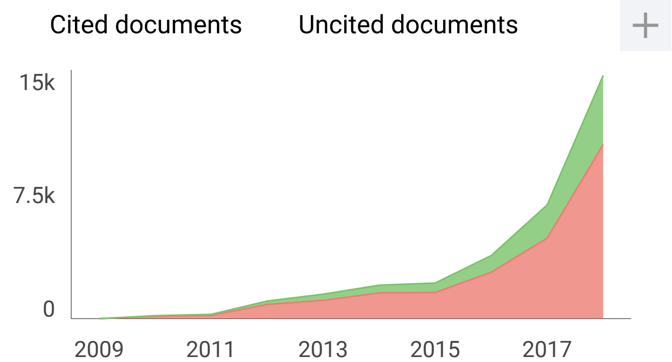

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