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Augmented Reality reducing energy uses and CO_2 emissions

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ABSTRACT

The Internet of Things (IoT) has created the opportunity for the development of new features such as virtual reality (VR), augmented reality (AR), mixed reality (MR) and extended reality (XR) and is now beginning to become more and more mature techniques. However, the implementation of these concepts has not been as fast in the industry as one might imagine. Tests that were conducted at some mining businesses, shows on many possible areas of use that can save energy and reduce CO_2 emissions and as well travel costs. In addition, it was verified that AR supported so that the remedy time was significantly reduced, thus minimizing production stoppages by more than 50% of the time, which in the end affects the Swedish GDP (BNP) positively. One concrete example with the alternative with AR was to solve a problem in a mine in Australia, where a three-year-old problem in a mine hoist was solved over an recorded AR call which later on was showed to 12 experts, from different parts of the world, over a skype meeting, saving principally some 15 MWh per person, or a total of 150 MWh, due to avoiding the long flights. In addition, a lot of time and by this money was saved as well! Predictions about how much energy can be saved are made if 50% of all the world's business travel is replaced by AR concepts, which was investigated in this essay. The amount corresponds to all of Sweden's total direct carbon dioxide emissions in one year which accounts for 70 Mton CO_2 per year.

Keywords: energy, internet of things, augmented reality, mining business, CO_2 emissions, troubleshooting time

1. INTRODUCTION

The total number of air travels have increased a lot the last 50 year [1] from 9,448,300 at year 1970 to 36,999,575 at year 2018, see Figure 1. During year 2018, these travels have transported 4.233 billion passengers. Meaning an average at 114 passengers per flight. It is not that simple to estimate how many of these trips that are business trips. 12 % of the airline passengers [2] are business-class passengers which bring 75 % of the profit to the airline operator due to both higher airfare but also due to higher spending onboard. A study in the US [3] state that only 7% of the business trips are longer than 1600 km. In addition, in the US, personal cars are used for 81% of business trips, but of the remaining 19% are mostly air travels [4]. As there are approximately 1.3 million people travel for work purposes every day, in the US and 19% are by air, it means some 250 000 business travels by air per day. 22% [5] of Europe´s GDP part relates to travel and tourism and correspond to business trips. The amount of business trips varies a lot. 62% of the European business travelers [6] are traveling once a year while 30% once a month. 44% of the business travelers visit a customer while 32% another company or site. A small fraction of the total number, 5%, travel 21 to 40 times per year, and would really benefit from more use of internet tools like Zoom, Teams or in combination with other techniques like for example augmented reality. A question then arises how necessary the business trips are? Here it depends on necessary for whom? Harvard Business Review [7] has evaluated how powerful personal face-to-face communication is compared to electronics like e-mail.

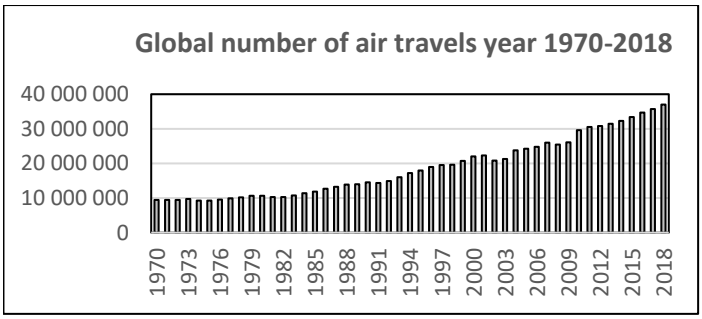

Fig 1 Development of number of Air transport, registered carrier departures worldwide, year 1970 to 2018.

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When they asked persons what they thought, people tended to say the two ways of communicating were equally good. But when a deeper evaluation of the results, related to won sales contracts, were performed it turned out to be 34 times more efficient with the face-to-face meeting! This has been calculated as money-wise and gives 12.5 $ back on each dollar spent on the business travel? Most likely any of the reality techniques or in combination could possibly achieve the same results. Another study [8] indicates that companies estimate a loss of 28% of existing business without the business trips. Both executives and business travelers believe, that they can convince 40% to become customers through face-to-face meetings, but only 16% otherwise.

2. BACKGROUND

To reach the Paris agreement the Swedish government has decided to become a fossil-free country in year 2045. This requires many activities to decrease carbon emissions, but also new technique for business interaction. One activity would be to consider if it is necessary to travel with airplane or with car (fueled by petrol, diesel) at all when new technique can make you feel you are in another place and interact in real-time with people around the globe with the help of new techniques like AR, VR, MR and XR? Where AR is an enhanced version of reality created by the use of technology to overlay digital information on an image of something being viewed through a device. Whilst VR can be described as an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment. MR is merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time. Mixed reality takes place not only in the physical world or the virtual world, but is a mix of reality and virtual reality, encompassing both augmented reality and augmented virtuality via immersive technology. Finally extended reality refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. In the future we also could expect real time hologram interactions [15].

A study at KTH [9] showed that the average emissions were 4800 kg CO_2 per year and full-time employee in year 2016, consequently to flying habits of researchers. Where costs for flying and other travel amounted up to 44 MSEK year 2016. Taken all universities into account with roughly 38200 employees and if we assume they all travelled with the same frequency, it would give the emissions to become 183 110-ton CO_2 per year. However, the figure need to be adjusted since not all employees at the universities are travelling with the same frequency or not at all (administrative staff). In a Swedish report [10] climate footprint from Swedish residents´ air travels have been estimated. In year 2017 there is one trip per person and year at average with the average distance 2700 km for a one-way trip. The direct emission from fuel CO_2 is 90 g CO_2/passenger and km, but if we include other effects like causing cirrus clouds and contrails the effect would be 170 g CO_2 eq. per person and km. Further estimations [12,13] other effects from cirrus cloud formation, NOx and contrail seem to increase this figure to some 4-5 % CO2 eq. of the global emissions. This can be compared to approximately 50 g CO_2 per passenger and km for long-distance travels by cars with an average of 3 persons in the car.

It was observed that 93% of the air travels was international in year 2017, thus only 7% domestic. The total emission from all these air travels then become 10-million-ton CO_2 eq. in year 2017, or approximately 1 ton/capita. This is approximately the same amount as for car use in Sweden and is approximately five times higher than the global average. In year 2010, IPCC [11] calculated that 2.6 % of all energy-related CO_2 emissions globally came from aviation, worldwide. Utilizing TEAMS or Zoom these emissions figures most likely could be reduced heavily when research conferences become digital, not to mention the travel costs it could save. With respect to covid-19 this is the case happening in year 2020 where research conference has been forced to transform into digital events and have proofed to be working well and efficient without any travels.

Anyhow for the industry it might not be so easy to use meeting technique like TEAMS especially when it comes to conduct troubleshooting and solving customer problems. This paper will focus on the augmented reality (AR) tests conducted around the globe for the mining business. A series of tests have been performed, during year 2018- 2020, together with the mining businesses suppliers in the automation industry to evaluate the technique.

3. METHOD

Several AR suppliers have been evaluated. What we wanted to study was first and foremost requirements for communication and networks to create AR calls in a mining environment. Furthermore, different hardware and software solutions currently on the market were tested to find the "best fit" for different purposes and business processes. Mainly considering that the technology communicates with different devices such as computer to mobile, mobile to mobile, iPad to mobile, computer and mobiles to wearables, and so on. The conducted AR tests included troubleshooting and interaction with customers, quality assurance and verifying products specially, those that are being shipped directly to a customer via suppliers, remote guidance and remote training both internally as for externally. Due to Covid-19 solutions with AR have been in focus to maintain the relationship with customers as for supporting them when problem occurs since it has not been possible with traveling to customers. In this paper the results from those test at mining businesses in Australia and Sweden will be discussed. Further on, since we are planning a full paper the method and tests will be explored there.

4. RESULTS AND ANALYSIS

From the conducted test the following positive effects by utilizing AR could be verified:

- Faster resolution time
- Rapid response calmed the customer
- First time fixe ratio increased
- Major saving through reduced downtime
- Access quick support from different parts of the world where the expert live
- Maintenance of diverse range of asset
- The recorded session could be viewed by others and thus used as training material
- Saving on travel costs
- Without having to travel (by air, car…) CO_2 emission decreased
- When travel was a must e.g. for exchanging a spare part, a rookie could do the trip whilst being remotely guided via AR by a senior at the office

A case, which occurred while the equipment was being tested, was a fault in a frequency converter. Instead of the supplier sending a service technician to the customer, they started an AR call and after a short time of troubleshooting, they could guide the customer how the problem could be solved. After half an hour of AR call, the error was remedied, and production returned to 100%. As a reference, it can be mentioned that a one-hour production stop costs the customer approximately 400 000 SEK. In normal cases, the supplier would go to the customer either by car or if expertise was needed that was not locally flown in from another country. A business trip that could take up to 6 hours before they would arrive at the customer's site with an equally long return trip. Facts from these tests show that there are many benefits that show that the new technology can contribute to reduce CO_2 emissions without customer suffering.

5. DISCUSSION

Starting with the 4.233 billion passengers 2018, and assume 12 % business passengers, it means 508 million business passengers. From these approximately 7% of these are longer than 1600 km, which was the case in the study [3]. A rough number than would be 7% of 508 million, or 8.4 million long distance business travelers. The North America count for 22% of the global air travels and assuming similar percentages it gives 38 million business trips annually longer than 1600 km. The total number of departures per year (2018) was 36999575 and aside of the 4 233 billion passengers also 220707 million ton-km freight need to be taken into account. The CO_2 emissions from transport is 20,5 % but from air approximately 2.6% or if including also other effects 4-5 % CO_2 eq. The average kg CO_2 per kg o.e. is 2.57 according to world bank [1] and the total global CO_2 emissions 36,138,285 kton (year 2018). Then the emissions from air transport would be 9,75825E+11 kg CO_2. Since the number on how much of this is related to business travels is lacking, assume 12 % which is the number of business class travelers in the US. This then means 1,17099E+11 kg CO_2, or if we use the additional effects as proposed multiplying with 1.9 we get 2,22488E+11 kg CO_2 eq. per year.

Now we come to how much of this could be decreased by using tools like Zoom, Teams or other virtual techniques. As we can see the business trip “issue” is complex. It has been observed that long trips lead to stress for both parents and children. At the same time young staff like traveling and the buzz-word “bleisure” is showing that many business trips are combined with pleasure activities, especially at long journeys. It is thus difficult to really know how to convince people to reduce the traveling when Covid-19 has passed. Further on some service trips seems to occur by the fact the engineer sees an opportunity to earn more money from reimbursing travel costs which gives extra salary. But also, some service manager sees and

budget extra revenue due to travel costs since it is not included in most of the service agreements. However, the customer would gain a lot by decreasing service trips from suppliers.

But if we make some assumptions it can be observed at least at what magnitude the possibilities of CO_2 emission reductions could be seen in Figure 2. As has been described earlier 75% of the airline profits comes from the 12% business travelers. This means that if the business travelers go down, the airlines will need to increase the price on pleasure travelers and others, which may reduce also that volume, probably with as much as the actual business travelers.

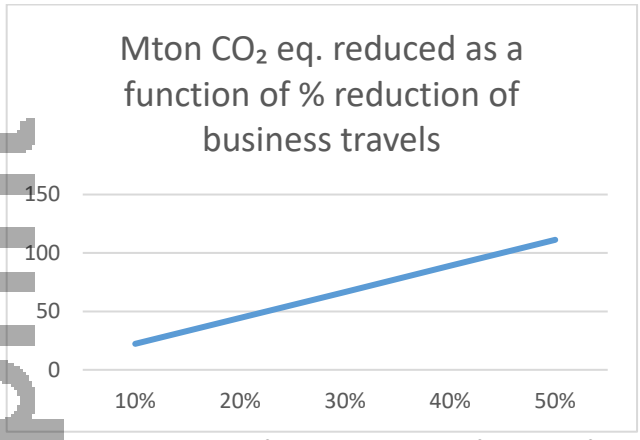

Figure 2 Reduction of MTon CO_2 eq as a function of % reduction of business travels.

Considering the direct CO_2 reductions, it should be possible to half this (see 25 % in Figure 2). In addition, assuming the effect on other travels due to higher prices for "normal" travelers might possibly give twice as high reduction. Looking at the reduction in oil equivalents it will reach 1 kg o.e. per kg CO_2, or 0.39 kg o.e. per kg CO_2. With roughly 10 kWh energy content in each kg o.e.

6. CONCLUSION AND FUTURE IDEAS

With the mentioned results it is obvious that some travel could be replaced by utilizing new technique like for instance AR and thus decrease CO_2 emission. Future features could be to develop learning methods with machine learning, image recognitions. By combining models [14] with the acquired recorded AR calls and images. Conditions are then shaped for AI applications which in turn could propose maintenance actions. This in turn allows and supports the mining business to be developed into a completely autonomous mining operation. Concluding from the conducted test, one of the supplier launched a new service, this spring, with AR to provide global service and troubleshooting (named remote insight) to their customers which turn out to be a success during the ongoing Covid-19.

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