1. introduction

2. literature review

2.1 IT usage and behavior changing

A hallmark of the emerging ‘information age’ is the diffusion and deepening of the information technology (IT) revolution (Castells 1997). The rapid development of IT brings many gadgets with it, such as smartphones, personal computers, mobile apps and so on (Joorabchi et al. 2013; Mahmood et al. 2001; Nishad and Rana 2016). This proliferation of IT products and applications has been experienced by most organizations and individuals. And not surprisingly, as people use these devices more frequently, researchers are studying the effects with growing interest (Greengard 2011).

A typical objective of most prior IT research is to explain the factors influencing the IT usage or acceptance. In the last decades, researchers built and tested several theorical models of IT usage (Taylor and Todd 1995; Venkatesh et al. 2003). Another major objective of IT research is to assess its value, mainly in business. Studies shows that IT usage is a key driver of organizational performance and can effectively improve productivity (Devaraj and Kohli 2003; Hitt and Brynjolfsson 1996).

Meanwhile, only a few researchers have reported on the use of IT products and applications for individual behavior changing. Researches are usually found in some certain fields like public health and business. Mattila et al. tried to record self-management of weight-related behaviors (Mattila et al. 2009), Hughes et al. developed an app for monitoring energy balance (Hughes et al. 2010), and others have monitored diet or physical activity as part of a program for diabetes (Årsand et al. 2010) or cardiac rehabilitation (Varnfield et al. 2011). Sundaram et al. suggested that the effective and efficient use of technology enhances salesperson performance (Sundaram et al. 2007). According to Hebden et al., software applications (apps) used on mobile devices are a novel technology that can be used to deliver behavior change interventions directly to individuals and have the potential to make a difference (Hebden et al. 2012).

Actually, IT can change even more than that. As environment and sustainability have been supposed to become game-changing megatrends in the near future (Lubin and Esty 2010), new thinking and innovation is urgently required. Green IT is put forward in this context. Patricia Ordóñez de Pablos gives the definition that“Green IT is the systematic application of practices that enable the minimization of the environmental impact of IT and allow for company-wide emission reductions based on technological innovations.” (Ordóñez de Pablos 2012). It essentially covers two goals, including reducing the amount of emissions released by IT systems and infrastructure, and reducing the emissions from business and production processes with the aid of IT. Green IT benefits a lot, with its saving our money, improving energy efficiency, lowering greenhouse gas emissions, and so on (Erek et al. 2011; Loeser et al. 2011; Murugesan 2008).

Since there isn’t any studies about the influence of Green IT usage on human behaviors, we plan to bridge the gap by discussing drivers’ driving behavior changes and the environmental impact of our app through an experiment.

2.2 Driving behavior and CO2 emissions

There is a growing emphasis on global effects of various air pollutants, especially for greenhouse gases and notably CO2. Road vehicles are acknowledged to be significant sources of a range of pollutants, and in 2018 they were responsible for 25% of total CO2 emissions from fuel combustion (IEA 2020).

CO2 emissions from road transport are of special concern, as they have been rising constantly (Gorham 2002). Some studies (Idso et al. 1998; Nasrallah et al. 2003) have measured and considered levels of CO2 to be representative of air quality similar to other pollutants that can have significant health effects (e.g. NOX, SO2, CO and PM10 ). In this respect, it is about time researchers researched on how to reduce CO2 emissions from road transport.

Except methods like better transport infrastructure, advances in vehicle technology and management systems (Nejadkoorki et al. 2008), only a few research showed that driving style has influence on greenhouse gas emissions as well. Alessandrini et al. have shown that women tend to consume and emit less than men because they push the accelerator pedal in a steadier way (Alessandrini et al. 2009). Gao et al. analyzed fuel consumption and NOx emission characteristics over various scenarios, and provided the guidance for eco-driving to achieve cleaner travelling (Gao et al. 2021). And Alessandrini et al. proves the influence of driving style on the environment by making an on road campaign, and adopting the tool developed by CTL (Centre for Transport and Logistics)(Alessandrini et al. 2012). In fact, eco-driving is a new approach to driving style developed since the mid '90s and nowadays it is a climate change initiative not to be overlooked (Alessandrini et al. 2012; Barkenbus 2010).

Therefore, one of the possible actions to reduce the environmental impact caused by road transport is to educate drivers to adopt a driving style that is as eco-friendly as possible. And we will use in-car sensor data to build regression models to see how each parameter relates to CO2 emissions.

3. Natural experiment design

3.1 Data collection

The goal of this work is to discover the impact of Green IT usage. Thus, we planned to choose CO2 emissions as dependent variable to show the drivers’ driving behavior changes and the environmental impact of the usage of our app, a product of Green IT.

*（下面这我用了过去时和现在完成时）*

The sample of vehicles monitored in the experiment has been selected from 63 different taxi drivers in xxx(公司). We obtained their driving data from July 2019 to October 2020 using OBD systems, which have been incorporated into the computers on-board new vehicles to monitor vehicle components and driving behaviors in recent years. Meanwhile, we invited these 63 taxi drivers to use our software application (护驾宝就是“Hujiabao”吗？), which can send alert to them when it detects risky driving behaviors and can provide a driving behavior ranking at the end of the day. We used the drivers' check-ins in the app to identify whether they had used the software that day.

(这里没有介绍数据特征——去除所有碳排放量为0，即缺失的记录项之后，得到11189 observations，21个变量。其中，为了保证正态性，将xxxx取logged data,更名为xxxxx。这些变量的缺失值用每个driver的每日数据均值替换。这里可以有个变量的表？但是21个变量确实似乎要缩减一点。).

3.2 Analytic strategy (这个模型我们好像没完全确定下来，所以这里有些细节我没有补充全)

We construct a linear regression model to investigate how the app usage and driving behaviors affect the CO2 emissions, as given next:

(+公式)

(这里解释公式)As described earlier, CO2 emissions (或者这里写log\_co2\_1), being the dependent variable, is get directly through the ODB systems of a car per day. (+Xxxxxxx) is the independent variable. xxxx and xxxxxx are the moderate variables. We use the driver's personal features (gender, age, driving experience) as control variables (这个应该是控制了好像，没有就后面控制了啥就写啥), and xxx is the idiosyncratic error term. Thus, we use Equation (1) to fit our data. The effect of aggressive driving behaviors and the app usage can be found by the sign and significance level of xxxx . The moderating effects are shown in the coefficients xxxxx. Further, we adopt xxxxx to verify the stability of the results.

Significance of the equation, each independent variable（还是说contributing factor） and coefficient was assessed using z tests and measured the effects of the presence of each independent variable on the strength of predictive relationships in the model. An α level of 0.05（我们的模型好像是这样） was adopted for our z test on each contributing factor. Analyses were conducted in 2021.

4. Priliminary results

5. Conclusion

Alessandrini, A., Cattivera, A., Filippi, F., and Ortenzi, F. 2012. "Driving Style Influence on Car Co2 Emissions," *2012 international emission inventory conference*.

Alessandrini, A., Orecchini, F., Ortenzi, F., and Campbell, F. V. 2009. "Drive-Style Emissions Testing on the Latest Two Honda Hybrid Technologies," *European Transport Research Review* (1:2), pp. 57-66.

Årsand, E., Tatara, N., Østengen, G., and Hartvigsen, G. 2010. "Mobile Phone-Based Self-Management Tools for Type 2 Diabetes: The Few Touch Application," *Journal of diabetes science and technology* (4:2), pp. 328-336.

Barkenbus, J. N. 2010. "Eco-Driving: An Overlooked Climate Change Initiative," *Energy policy* (38:2), pp. 762-769.

Castells, M. 1997. "An Introduction to the Information Age," *City* (2:7), pp. 6-16.

Devaraj, S., and Kohli, R. 2003. "Performance Impacts of Information Technology: Is Actual Usage the Missing Link?," *Management science* (49:3), pp. 273-289.

Erek, K., Loeser, F., Schmidt, N.-H., Zarnekow, R., and Kolbe, L. M. 2011. "Green It Strategies: A Case Study-Based Framework for Aligning Green It with Competitive Environmental Strategies," *PACIS*: Citeseer, p. 59.

Gao, J., Chen, H., Liu, Y., Li, Y., Li, T., Tu, R., Liang, B., and Ma, C. 2021. "The Effect of after-Treatment Techniques on the Correlations between Driving Behaviours and Nox Emissions of Passenger Cars," *Journal of Cleaner Production* (288), p. 125647.

Gorham, R. 2002. "Air Pollution from Ground Transportation," *An Assessment of Causes, Strategies and Tactics, and Proposed Actions for the International Community. New York: United Nations, Division of Sustainable Development, Department of Economic and Social Affairs*).

Greengard, S. 2011. "Living in a Digital World," *Communications of the ACM* (54:10).

Hebden, L., Cook, A., Van Der Ploeg, H. P., and Allman-Farinelli, M. 2012. "Development of Smartphone Applications for Nutrition and Physical Activity Behavior Change," *JMIR research protocols* (1:2), p. e9.

Hitt, L. M., and Brynjolfsson, E. 1996. "Productivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value," *MIS quarterly*), pp. 121-142.

Hughes, D. C., Andrew, A., Denning, T., Hurvitz, P., Lester, J., Beresford, S., Borriello, G., Bruemmer, B., Moudon, A. V., and Duncan, G. E. 2010. "Balance (Bioengineering Approaches for Lifestyle Activity and Nutrition Continuous Engagement): Developing New Technology for Monitoring Energy Balance in Real Time," *Journal of diabetes science and technology* (4:2), pp. 429-434.

Idso, C. D., Idso, S. B., and Balling Jr, R. C. 1998. "The Urban Co2 Dome of Phoenix, Arizona," *Physical Geography* (19:2), pp. 95-108.

IEA. 2020. "Co2 Emissions from Fuel Combustion by Sector in 2018." 2020, from <http://www.iea.org/publications/freepublications/publication/co2-emissions-from-fuel-combustion-highlights-2020.html>

Joorabchi, M. E., Mesbah, A., and Kruchten, P. 2013. "Real Challenges in Mobile App Development," *2013 ACM/IEEE International Symposium on Empirical Software Engineering and Measurement*: IEEE, pp. 15-24.

Loeser, F., Erek, K., Schmidt, N.-H., Zarnekow, R., and Kolbe, L. M. 2011. "Aligning Green It with Environmental Strategies: Development of a Conceptual Framework That Leverages Sustainability and Firm Competitiveness," *AMCIS*: Citeseer.

Lubin, D. A., and Esty, D. C. 2010. "The Sustainability Imperative," *Harvard business review* (88:5), pp. 42-50.

Mahmood, M. A., Hall, L., and Swanberg, D. L. 2001. "Factors Affecting Information Technology Usage: A Meta-Analysis of the Empirical Literature," *Journal of organizational computing and electronic commerce* (11:2), pp. 107-130.

Mattila, E., Korhonen, I., Salminen, J. H., Ahtinen, A., Koskinen, E., Särelä, A., Pärkkä, J., and Lappalainen, R. 2009. "Empowering Citizens for Well-Being and Chronic Disease Management with Wellness Diary," *IEEE Transactions on Information Technology in Biomedicine* (14:2), pp. 456-463.

Murugesan, S. 2008. "Harnessing Green It: Principles and Practices," *IT professional* (10:1), pp. 24-33.

Nasrallah, H. A., Balling Jr, R. C., Madi, S. M., and Al-Ansari, L. 2003. "Temporal Variations in Atmospheric Co2 Concentrations in Kuwait City, Kuwait with Comparisons to Phoenix, Arizona, USA," *Environmental Pollution* (121:2), pp. 301-305.

Nejadkoorki, F., Nicholson, K., Lake, I., and Davies, T. 2008. "An Approach for Modelling Co2 Emissions from Road Traffic in Urban Areas," *Science of the total environment* (406:1-2), pp. 269-278.

Nishad, P., and Rana, A. S. 2016. "Impact of Mobile Phone Addiction among College Going Students," *Advance Research Journal of Social Science* (7:1), pp. 111-115.

Ordóñez de Pablos, P. 2012. *Green Technologies and Business Practices: An It Approach: An It Approach*. Information Science Reference.

Sundaram, S., Schwarz, A., Jones, E., and Chin, W. W. 2007. "Technology Use on the Front Line: How Information Technology Enhances Individual Performance," *Journal of the Academy of Marketing Science* (35:1), pp. 101-112.

Taylor, S., and Todd, P. A. 1995. "Understanding Information Technology Usage: A Test of Competing Models," *Information systems research* (6:2), pp. 144-176.

Varnfield, M., Karunanithi, M. K., Särelä, A., Garcia, E., Fairfull, A., Oldenburg, B. F., and Walters, D. L. 2011. "Uptake of a Technology‐Assisted Home‐Care Cardiac Rehabilitation Program," *Medical Journal of Australia* (194), pp. S15-S19.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. 2003. "User Acceptance of Information Technology: Toward a Unified View," *MIS quarterly*), pp. 425-478.