Surveying public attitudes towards the use of surgery robots in Europe

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***Abstract*— Current surgical robots are an extension of surgeons' arms and an essential aid in supporting doctors autonomously in crucial surgery moments. A growing part of the literature has expanded the knowledge on these medical devices' legal and regulatory aspects, such as safety, control, responsibility, performance, and cost. Between 2015 and 2019, Special Eurobarometers conducted by the EU indicated that people were uncomfortable with robots caring for older adults or performing surgery on them. Despite these findings, surgery automation has advanced silently in recent years, and many hospitals currently include robot-assisted surgeries. Given the apparent disconnect between surgical technology advancements and general public perception toward robots and autonomous systems, we survey the European public attitudes toward surgery automation in this article. Our questionnaire generally sought to re-evaluate and measure surgical robots' general acceptability and understand and analyze people's thoughts on autonomous surgery robots. The survey also included critical questions relevant to future policy-making, such as bestowing separate identities to surgery robots and liability allocation mechanisms. The study results differed slightly from previous similar data and denoted a more positive outlook concerning surgery automation.**

Keywords— surgery robots, public attitudes, robot autonomy, healthcare robots.

I. Introduction

The extent to which the public can enjoy the rights often depends on how the concerning technology is determined by existing or new rules that govern these recent advancements. Information about the attitudes and opinions of citizens and professionals is a critical component of the policy formation process because they help establish the legitimacy of a policy framework and ensures the inclusion of balancing exercises between the public and the private, often diverging interests [1]. In the case of robot and autonomous systems, these public attitudes often reveal confidence, trust, and acceptability levels from the public, which is a core topic for further technology adoption, including AI and robotics for the EU [2-3].

In the European Union (EU), Special Eurobarometer 382 on public attitudes towards robots, 427 on autonomous systems, and 460 on the impact of digitization and automation on daily life indicate a gradual and slow increase in the comfort levels towards acceptability for different types of robot technology and autonomous systems [4-6]. However, the overall results suggested that the European public was not very optimistic about the idea of robots in healthcare settings taking care of the elderly or performing surgery (see Graph I).

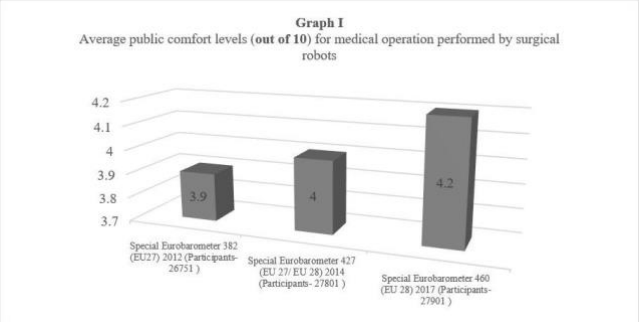

Fig. 1 Average public comfort levels (out of 10) for medical operations performed by surgical robots

Despite these findings, surgery automation has advanced silently in recent years, and many hospitals currently include robot-assisted surgeries [7]. Surgeons have been using minimally invasive surgery techniques to support their work and performance for over two decades [8]. However, there has never been any significant apprehensions around acceptability, trust, and adoption among the public, since most surgery robots were considered a medical device that merely extended surgeons' arms.

While recent literature explores the multiple effects robot technology may have on care networks and relationships [9], less is known about how robot technology impacts surgery ecosystems, including surgeons, health staff, patients, and the general population. Given the increasing autonomy levels of medical robotics, in particular surgery robots [10-12], and the recent advances in tech policy surrounding robotics and AI, we surveyed the public attitudes toward increasing levels of surgery automation. This article captures the general public's perceptions of surgical robots, a technology that, despite its exponential adoption, often shows moderate results compared to traditional approaches and is more expensive [13-14].

II. Methods

Given the apparent disconnect between surgical technology advancements and general public perception toward robots and autonomous systems, we survey the European public attitudes toward surgery automation in this article.

A detailed exploratory questionnaire geared toward understanding the public attitudes towards surgery automation was prepared on MS Forms with precisely 13 questions with a branching method, i.e., participants were shown the questions based on their answers. The survey covered topics connected to the comfort level of people with

surgical robots performing surgery, the level of medical supervision of health professionals in autonomous robots surgery, the liability allocation framework following autonomous surgery robots induced harm, and the potential legal identity of surgical robots.[1]

We used the online platform Prolific to launch the survey.[2] Before taking the survey, participants were informed about what autonomous surgery robots are, how they function, and the current status of such advancements. Although a total of 1112 participants filled up the survey, the analysis in this paper is based upon the extracted data of 750 survey forms received from participants of European nationality. Four forms were deleted because the details of the participants could not be cross-checked and verified.

Concerning the limitations, we encounter three significant caveats. Firstly, more than 51% (total of 382) of the participants were between the age group of 16 years to 25 years, closely followed by the age group of 26 years to 35 years, forming 31% (total of 233). Therefore, most participants were relatively young, and their public perception could be biased based on their modern technological outlook. Another limitation is the number of participants: while 750 responses are a significant number of respondents, previous Eurobarometers included the opinion of more than eighty thousand people. In other words, extrapolations from our work would require careful consideration and more extensive survey work. Last but not least, some of the questions covered projected futures involving legal and ethical questions surrounding autonomous surgical robots, although those not being a full-fledged reality yet [15-16].

III. Results and Discussion

Our survey looked at public perceptions of surgery automation. In it, we covered a variety of questions connected to liability and identity allocations, comfort levels towards automation, medical supervision, and how people would want to see risk and liability allocations considering the automation involved in the process.

A. Increased positive outlook towards surgery automation

We asked participants about their comfort levels with the introduction of fully autonomous surgical robots as alternatives to traditional medical surgeries. This question implied the scenario where surgeons were either completely uninvolved or only supervised the surgery. As depicted in Graph II, 63% of the participants positively expressed their comfort with fully autonomous robots (472 respondents combining 41 extremely comfortable, 235 moderately comfortable, and 196 slightly comfortable). If we compare this result with earlier surveys conducted by the EU, we see a noticeable increase in the public's positive perception of autonomous systems performing actions that traditionally were performed solely or partly by humans. While increased trust traditionally relates to easy technology adoption, such perception typically surveys end users, like consumers, which in the context of surgery robots are doctors and not patients [17-18]. Moreover, it would have to be contrasted with existing research on performance and cost, which currently indicates moderate results compared to traditional approaches and is more expensive.

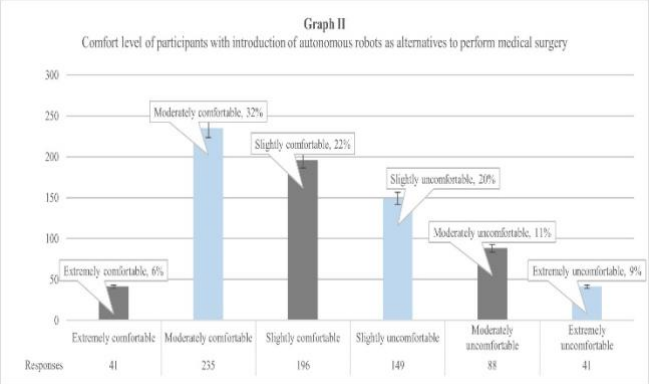

Fig. 2 Comfort levels concerning robot-assisted surgeries as replacement for traditional surgeries

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B. Supporting autonomous surgeries human oversight

Further, an increase of around 25% in comfort levels of the same participants (up to 88%) occurred when asked if they preferred some medical supervision involved in autonomous surgical procedures (*see* Graph III). When asked, thus, people seem to prefer expert human involvement in RASs rather than humanless surgeries, which will give them an additional layer of trust, comfort, and relief.

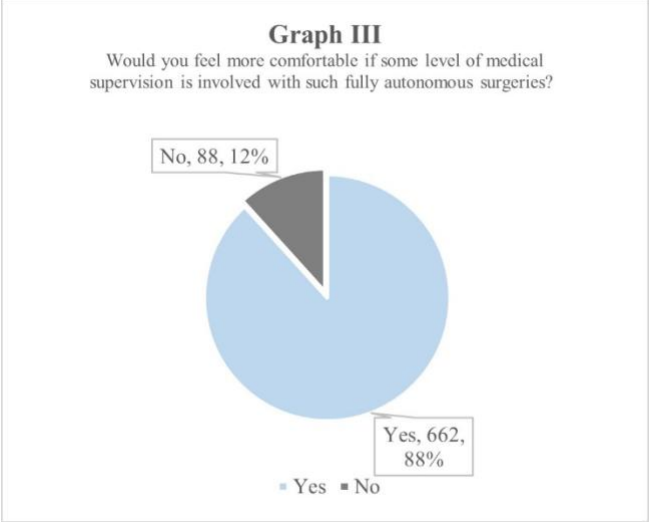

Fig. 3. Public comfort levels relating to surgeons' RAS oversight

The relationship depicted by the public between surgery automation and human oversight seems to mirror the idea the HLEG on AI from the EU had for creating policies that would support 'trustworthy AI' [2]. This direction seems to be where technology is developing toward, at least for now: a future in which, in the specific context of surgery automation, surgeons' performance decreases with progressive levels of autonomy and oversight increases [10-11].

[1] Our survey questions can be found following this link.

[2] *See* https://www.prolific.co/.

C. Changing roles and responsibilities in the operating theater

Autonomous surgical robots transform essential tasks of health professionals. If surgeons' roles and responsibilities change due to the inclusion of complex cyber-physical systems for performing surgeries, an obvious question about liability comes to mind [10]: who is responsible if something goes wrong? Since respondents felt more comfortable with the involvement of health professionals in surgery procedures, it was no surprise when we asked this question to find out that they felt doctors should be put through the same liability obligations even when they use autonomous surgical robots. 67% preferred the liability regime to stay as it is today (*see* Graph IV), i.e., most participants wanted health professionals and hospitals to be responsible for any error or harm caused during the procedure. Such liability obligation seems a general hope that would deter surgeons from acting negligently if autonomous surgical machines take care of major surgical procedures. This finding relates to the effects of automation in another delicate context, e.g., in aviation. Researchers keep highlighting that, although less critical than the public opinion or media, the automation of primary critical flight operations could deteriorate the cognitive skills needed for manual flying could be reduced depending on the degree to which pilots remain actively engaged in supervising cockpit automation [19].

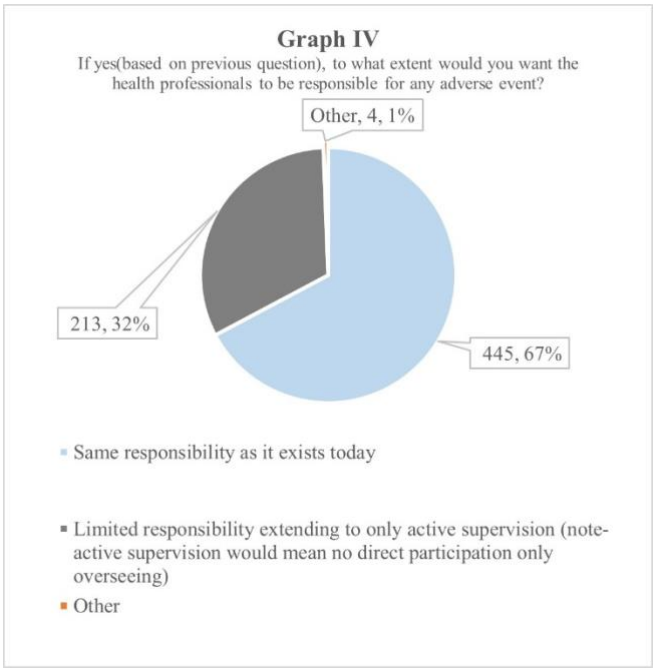

Fig. 4. Public opinion on the responsibility following an adverse event in robot-assisted surgeries.

There are debates and discussions about the responsibility allocation between different actors involved, from manufacturing to the usage of surgical robots [20]. There are also discussions around the responsibility of manufacturers for autonomous tasks performed by the robots [21]. In our questionnaire, we also asked questions about the responsibility of manufacturers of fully autonomous surgical robots. In theory, manufacturers are responsible for the correct and efficient functioning of the autonomous features of the robots. It is then imperative that they ensure that the technology lives up to the hype created in the health innovation market. When participants were asked if they would want the manufacturers to be held responsible for technical faults, most participants (89%) overwhelmingly agreed (*see* Graph V).

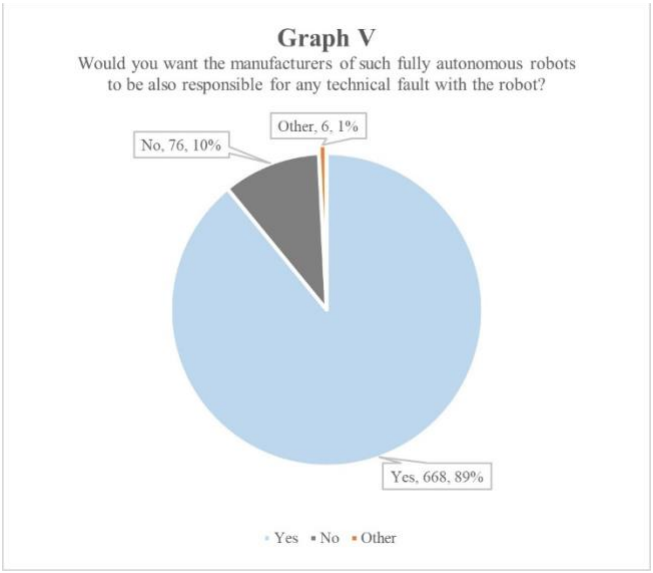

Fig. 5. Opinion concerning manufacturers' responsibility for technical faults.

Often easier said than done, such an affirmation raises questions concerning chains of responsibility, which would undoubtedly lead to blaming legal battles to determine who was responsible for the damage caused. Some researchers gave the first thought to this issue and put forward several pathways that could help: 1) a robot impact assessment for risk reduction and 2) the 'robo-terms,' a framework inspired by the International Commercial Terms (Incoterms®) for product sales (which defines the rules for international traders' responsibility) that could simplify the allocation of responsibility in highly automated environments [12]. The robo-terms establish a clear transition of responsibility in surgery automation that goes from the pre- to the post-installation phases, including general requirements, before, during, and after the surgery.

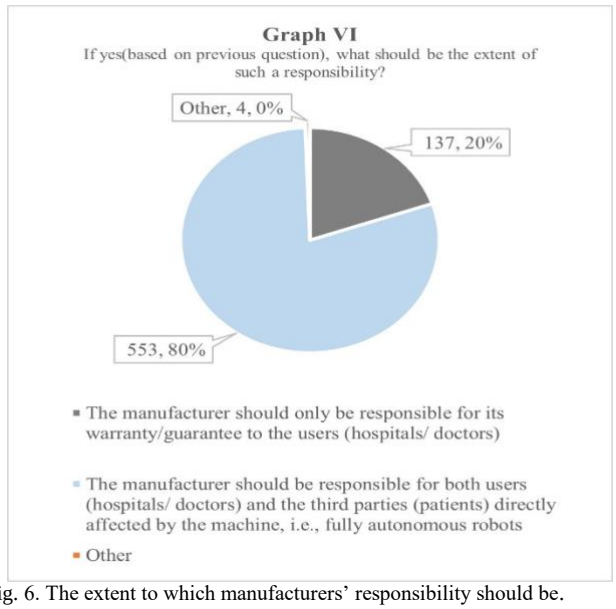

Fig. 6. The extent to which manufacturers' responsibility should be.

For our respondents, the logistics of allocating such responsibility to manufacturers for any technical fault was divided on whether it should be limited to users, such as doctors or hospitals, or extended to third parties such as patients. A total of 553 respondents (80%) preferred

manufacturers to be held responsible for both the users and the third parties (*see* Graph VI).

D. Letting the robots be mere robots

As the autonomy levels of robots and AI technologies may soon achieve human-like efficiency and even beyond, part of the scholarship reflected on the legal status of these technologies. From animal-like to corporations [22-23], the agenthood of robots has been the subject of discussion for some time. The European Parliament, for instance, put forward a resolution in the EU policy spheres considering bestowing separate digital identities to autonomous robots [24]. Statements like this pushed part of the community to state that robot-oriented regulations seem premature, misguided, or even dangerous [25]. Their main argument was that robots are at an early stage, and misconceived regulation could hinder the development of such technology and prevent society from benefiting from them. Following these rather academic discussions, we were curious about the comfort levels of the European public concerning surgical robots with a particular category of legal status.

We gave respondents two examples of providing this digital/legal identity to surgical robots. The first one considered each such robot a separate legal person/digital person. The second one gave autonomous robots a loosely legal status similar to a company with its directors and shareholders, whereby doctors and manufacturers were the directors (i.e., having fiduciary duty). The overall results indicate that people are not very comfortable with the idea of endowing robots with a specific legal status.

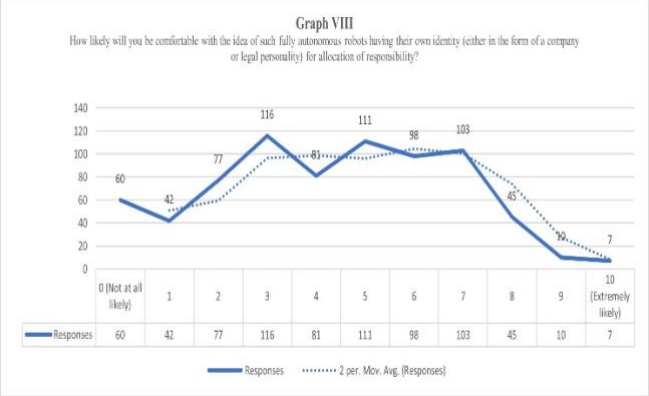

Fig. 7. Comfort levels with the idea of giving legal personality to autonomous surgical robots.

The idea was to see in what forms people would be comfortable with robots having their separate legal/digital identity. As the fault-based liability will ultimately lie with someone other than the robots, there will be a need to have some mechanism to assign liability or to segregate it for better allocation of the responsibility with autonomous surgical robots.

IV. Conclusions

After It is not uncommon to see technology-driven, policy-encouraged advancements without general population agreement, support, or consideration. Despite research discussing how technology adversely affects human behavior [26-27], our brains [28-29], or nature [30], there is a commonly agreed narrative that technology can fix complex societal problems when in reality, it cannot [31]. Unsurprisingly, this push can be found within the realm of health technology [7-8]. Many hospitals have surrendered to the promise of AI and robotics. They silently have incorporated surgical robotics despite these devices not being cost-effective or performing better than traditional procedures [13] and without the general public support, at least as stated by the detailed surveys conducted by the EU institutions on public attitudes towards robotics and automation [4-6].

This article surveyed the European public attitudes toward surgery automation in this context and hoped some of the takeaways could influence health policy choices considering the often unheard voices of the general public. In general, our N=750 sample reveals more positive comfort levels concerning surgery automation. Still, there is the general belief that a human should supervise autonomous surgeries, which may mean that the public is not ready for humanless surgeries, but yes, with surgeon tasks shifting from performance to oversight [10-12]. Although our results show that young populations have a considerably different outlook toward robot-assisted surgeries, especially autonomous surgery robots, this could be explained because they are more tech-savvy but also more inexperienced in life than the adult population. Of course, more data should be collected in this respect to make final conclusions.

Our survey also touched upon some important topics, such as separate legal identity and liability allocation between different parties, and found out that, in general, there is a general agreement that a separate legal entity for robots is not desirable. The possibility of having the manufacturer share part of the responsibility with the doctors seemed plausible and attractive to respondents. Shared responsibility should be assessed appropriately since understanding where particular harm originated in complex cyber-physical ecosystems where many parties are involved may prove extremely difficult [32-33].

Unknown remains the long-term effects of this task shift on the human surgeon's cognitive and academic skillset: whether unused tasks will gradually be unlearned, whether there will be more reliance on automated tasks, or whether education will have to change. Such an analysis should address different levels of analysis covering individual (micro-level, at the operation theater level), intermediate or organizational (meso-level, at the hospital and in the practitioner-patient level), and collective, social, and economic (macro-level, relating to educational changes and health policies fostering healthcare automation) [34]. Future work will include more detailed results on the entire survey covering interesting perspectives from often unattended continents, such as Africa.

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