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# Acceptability and 5G in the Medical Field: The Impact of the Level of Information

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**Abstract**—The issues around 5G are considerable: sovereignty, smart city, industry 4.0, energy, connected healthcare. However, 5G is currently raising many questions from the general public and professionals. To better understand these questions related to acceptability, a quantitative experimental study was conducted with 81 healthcare professionals, via an online questionnaire. The objective is to analyse the impact of the level of information on acceptability. The participants were divided into two experimental groups, confronted either with a low level of information or a high level of information about 5G. Several dimensions were analyzed (perceived usefulness and usability, intention to use, harmfulness and perceived environmental impact). The results show a significant influence of the level of information related to 5G on the number of "I don't know" responses participants. More broadly, this study demonstrates the influence of respondents' level of information on their ability to express an opinion. These results provides insights for the construction of survey and public policies around 5G and new technologies acceptability.

## I. INTRODUCTION

The fifth generation (5G) of mobile communications and networks enables a broadband and reliable connectivity to a constantly growing number of devices of many kinds [1], [2]. Unlike the previous generations, the 5G technology does not only focus on the connectivity of individuals' user equipment, but also takes part in the digital transformation of the so-called verticals [3], among which the transport, the industry 4.0, or the e-health. The acceleration of the 5G deployment inherently raises the issue of the acceptability of this technology by the users, not only in their personal life, but also in their professional use. In fact, forms of distrust and resistance towards 5G has been recently observed in some countries where it is being deployed.

In this paper, we focus on the acceptability of 5G in a professional use within the field of healthcare. Thus, the current study aims to evaluate the effect of the level of information about 5G on acceptability among potential healthcare users, *i.e.* all people working in hospital and healthcare centers. The presented results reveal that the higher the level of information, the more people are able to assess their perception of 5G. Indeed, more Don't Know (DK) responses are present within the low level of information group, comparatively to the second group "high level of information. Such a study could then help the operators of public and private 5G networks

to manage the acceptability of the users in their professional field.

### A. State of the Art

Numerous studies have been conducted to understand the adoption of new technology, as evidenced by the number of meta-analyses on this topic (e.g., [4]–[6]). Relying on acceptability theory, it aims to discover the factors that facilitate or inhibit technological product adoption (e.g., [7]). One of the best-known theoretical models of acceptability is probably the Technology Acceptance Model (TAM) [8] which supposes the influence of two variables on the intention to use: the perceived usefulness and the perceived ease of use. The TAM seems to be appropriate, with additional variables, to predict the usage of 5G [9].

5G is still a technology in development. Studies have already been carried out on technical performance (e.g., [10]), on issues and costs related to its deployment (e.g., [11]) on public health and environmental implications (e.g., [12], [13]) and in terms of quality of experience perspective (e.g., [14]). Nevertheless, few studies have focused on investigating user acceptability towards 5G. According to Akbari et al. (2020), there are "insufficient in-depth discussions of intention to use from the potential user perspective" ([9], p. 7). These authors study the acceptance of 5G among students. They show for example that trust mediates the relationships among perceived ease of use, perceived usefulness, and the intention to use 5G. Trust seems to be an important factor in driving behavioral intentions (*i.e.*, [15], [16]). For Akbari (2020), "trust refers to specific beliefs about the way that technology operates through a work environment" ([9], p. 3). Trust refers to specific beliefs about how technology works in a professional environment [17]. Some authors have also investigated the factors influencing the intention to use 5G mobile communication service, based on an extended version of TAM (ETAM) [18]. For Koh et al. (2020), "perhaps owing to the newness of the 5G network's development, no study has been published on risk perception of electromagnetic waves from 5G network base stations" ([19], p. 492). In parallel, Lin et al. (2020) focused on user satisfaction with 5G, via online questionnaires [20]. Along with these different variables influencing acceptability and intention to use, it seems that the framing information or the level of information can have also an impact on

the adoption of new technologies. For example, Vishwanath (2009) has shown that there could be a "framing effect" related to the adoption of new technologies [21]. Indeed, the type of words used, which can have a potentially framing effect, and therefore the type of information conveyed to the user about a technology has consistently been shown to be one of the strongest biases in decision making [22]. However, to the best of our knowledge, no study has been carried out on the impact of level information on 5G acceptability. In this period of intense debate around 5G, where the information is abundant and possibly influencing, it seems necessary to propose a study that comes to address this issue, i.e., to better understand the impact of communication policies on the perception of users towards 5G.

### B. Contributions

The contributions of the paper are multiple:

- The study is original since, to the best of our knowledge, studies on the acceptability of 5G are rare, even when distrust towards 5G is observed in many countries deploying this new technology.
- It is based on an experimental and robust protocol, and in the same times, it suggests to test news dimensions such as the perceived impact on health or environment, as these are key issues inherent to 5G. The protocol could then be reused in larger scale studies in different professional fields where 5G will be used.
- It provides results about the acceptability of 5G that could help operators in the deployment of public or private 5G networks.
- It provides crucial insights in terms of public policies, on the impact of the level of information on the ability of respondents to express an opinion and respond to acceptability surveys around new technologies and 5G in particular.

The rest of the paper is organized as follows: Section II describe the methodology of the study. Section III provides the obtained results, which are then discussed in Section IV. Finally, Section V concludes this paper.

## II. METHODOLOGY

### A. Participants

The data has been collected from the responses to an online questionnaire, whose items are available at URLLINK. A set of 81 participants (44 women, 18 men & 19 others/don't want to answer; mean age = 43.03 years, SD age = 11.35) have been involved in this study. Volunteers were recruited by email using a professional network, composed of french hospitals and healthcare institutes. The participants were randomly divided in two conditions : half of the participants are assigned to the condition "low level of information", the other half to the condition "high level of information". These conditions are different in the type and amount of information provided to participants about 5G.

### B. Protocol

The participants filled the survey using the online Survey-Monkey platform. The survey started by the presentation of the following instruction (in French):

*"The French Institute of Research and Technology b<>com is currently carrying out a study on the perception of health-care professionals towards 5G. For this, we need your advice. The data collected during this survey will be only processed confidentially and anonymously for statistical purposes. The results will be used for scientific purposes. There are no right or wrong answers, only your opinion matters. This study is intended for all professionals in the medical field and does not require specific knowledge about 5G."*

Then, the participants were randomly distributed in both conditions (i.e., low level of information and high level of information). In the condition "**low level of information**", the participants had to read the following description:

*"5G is the fifth generation of mobile telephony, allowing high-speed connectivity / connection to any type of mobile terminal (smartphones but also vehicles, sensors, etc.)"*

In the condition "**high level of information**", in addition to the description of the condition "low level of information", the participants had to read the following description:

*"It is characterized by higher throughput (up to 100 times more data transmitted per second), lower latency (i.e., shorter response time) for better energy efficiency and higher high reliability than previous generations of mobile telephony (e.g., 3G / 4G). 5G could allow significant progress in telemedicine and thus improve access to healthcare for as many people as possible. It would thus promote the emergence of certain applications: telemedicine, for remote medical, reliable, high-speed and secure monitoring; Operating rooms and connected ambulances for better patient monitoring; Secure data transfers for scientific research purposes; etc."*

After reading this instruction, participants had to complete the survey. Data collection took place without supervision and participants could leave the questionnaire whenever they wished. The order of items in the questionnaire was randomized to avoid order effects [23].

### C. Measures

Such as aforementioned, the TAM [8] and related questionnaire has been used to evaluate the acceptability of medical professionals towards 5G. Thus, perceived usefulness, perceived ease of use, and intention to use has been evaluated. In addition, personal innovativeness [24] as well as perceived impact on health, perceived impact on environment and perceived level of information have been assessed. The trust and distrust dimensions were also studied [25].

To evaluate all these dimensions, participants were asked to indicate their agreement based on five-point Likert scales (1 = totally disagree; 5 = totally agree). Completion of each item was mandatory. However, for each item, a "don't know" (DK) response was made possible for the participants. They therefore had the option of not responding to the item, if they wished, by checking this case. Finally, in order to identify inattentive respondents and to ensure that participants correctly classified the level information of each condition, an item of attention check was introduced. At the end of the questionnaire, the instructions were as follows (in french): "Please choose the title that best corresponds in your opinion to each of the following paragraphs describing 5G". The two descriptions used in the experimental groups were presented to all participants. For each description, participants had to choose between two items:

- Factual description of 5G
- Description of 5G, its characteristics and applications

In summary, the following dimensions have been evaluated using 36 items:

- Acceptability - TAM
  - Usefulness - 4 items (e.g., "Using 5G would improve my job performance")
  - Ease of use - 4 items (e.g., "My interaction with 5G medical applications would be clear and understandable")
  - Intention to use - 3 items (e.g., "Assuming that I have access to the 5G in the medical field, I intend to use it")
- Trust - 6 items (e.g., "I can trust 5G in the medical field")
- Distrust - 4 items (e.g., "I am wary of 5G in the medical field")
- Personal Innovativeness - 4 items (e.g., "Among my peers, I am usually the first to try out new information technologies")
- Perceived impact on Health - 3 items (e.g., "5G will be harmful to my health")
- Perceived impact on environment - 3 items (e.g., "5G will make it possible to be more respectful of the environment in the medical field")
- Perceived level of Information - 3 items (e.g., "I believe I have access to enough information about 5G")
- Demographic variables - 2 items (i.e., Gender and Age)

### III. RESULTS

In this section, we provide and analyze the results obtained from the responses of the questionnaire. They will be further discussed in Section IV. The data analyzes were performed using R [26], and the results regarding the impact of the conditions (i.e., the level of information) have been gathered and displayed using Matlab.

In order to verify the relevance of the proposed level of information (i.e., low level of information and high level of information), we evaluated that participants correctly classified the level information of each condition. For the condition

"low level of information", 91.5% of participants correctly classified the description. For the condition "high level of information", 78.7% of participants correctly classified the description. These results show that the levels of information provided are relevant and that it is possible to analyze their effects in depth.

#### A. Influence of level information on "Don't know" responding

The influence of level information on DK responses was evaluated using the usual chi-square analysis. The results are presented using the American Psychological Association (APA) style, *i.e.*

$$\text{Dimension}(\chi^2(D, N) = X, p), \quad (1)$$

where "Dimension" is the tested dimension (*e.g.* the usefulness),  $D$  is the degree of freedom of the data,  $N$  represents the size of the sample (the number of responses),  $X$  is the result of the  $\chi^2$  test, and  $p$  is the  $p$ -value. The latter indicates the significance of the level of information on the propensity of the participants to answer/not answer with a DK response (the lower the  $p$ -value, the more significant the result).

Analyzes showed that level information has a significant impact on the number of "I don't know" responding on

- Usefulness:  $\chi^2(1, N = 114) = 17.43, p < .001$
- Ease of use:  $\chi^2(1, N = 114) = 11.48, p < .001$
- Trust:  $\chi^2(1, N = 114) = 21.33, p < .001$
- Distrust:  $\chi^2(1, N = 114) = 5.96, p = .001$
- Intention to use:  $\chi^2(1, N = 114) = 18.01, p < .001$

However, no significant difference was observed on:

- Personal innovativeness:  $\chi^2(1, N = 114) = 0.01, p = .918$
- Perceived impact on health:  $\chi^2(1, N = 114) = 3.70, p = .055$
- Perceived impact on environment:  $\chi^2(1, N = 114) = 1.49, p = .222$
- Perceived level of Information:  $\chi^2(1, N = 114) = 2.44, p = .110$

These results show that the participants are more inclined to not respond with DK when the level of information is high, for the usual TAM items measuring the acceptability of a technology (*e.g.*, usefulness, ease of use). Thus, the level of information increases their capability to build an opinion about 5G regarding these dimensions. Conversely, the level of information has a weaker influence on the amount of DK responses related to the dimensions we added such as "perceived impact on environment" (the number of DK response is low in both cases). This result shows that the participants have an *a priori* opinion regarding these new dimensions we tested. To summarize, these analyzes show that the level of information makes it easier to assess the qualities of 5G for future users. But this does not change their judgment on impacts related to health or the environment.

#### B. Influence of level information on judgement

The effect of level information on judgement toward 5G was evaluated using the Student's t-test. The results of the t-

test are presented using the same style as the previous results for the  $\chi^2$  tests.

The results showed only a significant effect on Perceived level of Information ( $t(73.17) = -3.13, p = .003$ ). The participants in the condition "high level of information" perceived actually a higher level of information about 5G ( $M = 3.62, SD = 0.96$ ) compared to condition "low level of information" ( $M = 3.23, SD = 0.93$ ). All descriptive statistics are listed below and reported in Fig. 1 in the form mean/standard deviation.

No significant effect was found on:

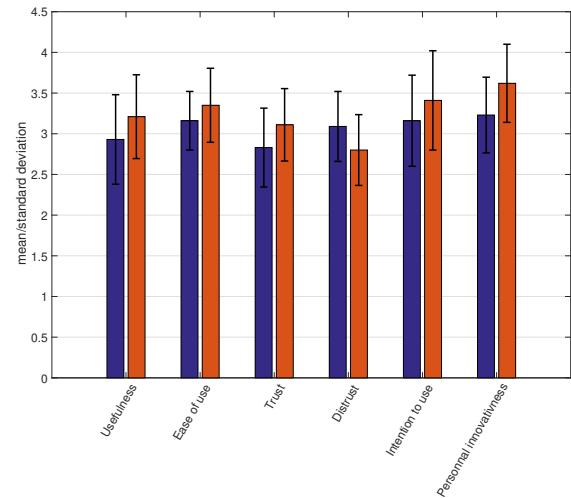
- Usefulness:  $t(74.36) = -1.17, p = .245$
- Ease of use:  $t(69.83) = -0.99, p = .326$
- Trust:  $t(70.70) = -1.31, p = .195$
- Distrust:  $t(75.99) = 1.47, p = .145$
- Intention to use:  $t(71.95) = -0.94, p = .348$
- Personal Innovativeness:  $t(78.13) = -1.84, p = .069$
- Perceived impact on Health:  $t(68.95) = 0.06, p = .951$
- Perceived impact on environment:  $t(66.94) = 0.57, p = .571$
- Perceived level of Information:  $t(73.17) = -3.13, p = .003$

Although no significant effect of the level of information on the judgement toward 5G has been clearly highlighted, Fig. 1-(a) nevertheless shows that, in average, the participants with the higher level of information are more inclined to use, trust, or find useful the 5G than the participants with low level of information. Conversely, the level of information seems to have no effect on the judgement toward the new tested dimensions (impact on health and environment), according to Fig. 1-(b). However, the standard deviation is too high to highlight further statistics, due to the low number of participants.

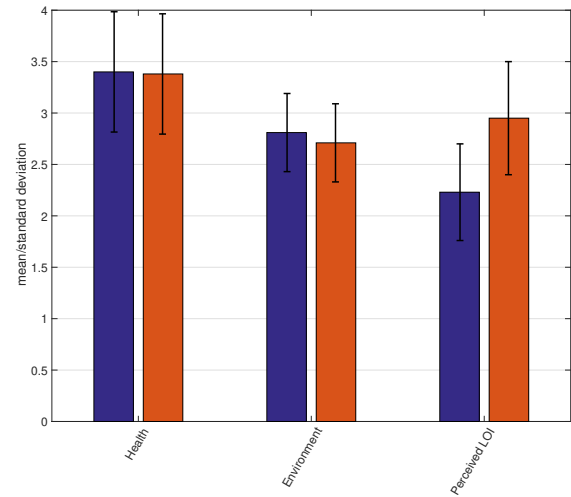
#### IV. DISCUSSION

An experimental study was done in order to evaluate the influence of information level on acceptability towards 5G among healthcare professionals. For the participants evaluating 5G (participants which don't answer "I don't know"), the level of information did not significantly directly influence their judgment, but this should be confirmed with a much larger number of participants. Nevertheless, the results showed an effect on "don't know" responding. Participants exposed to a lower level of information tend to be significantly less able to evaluate their perception towards 5G. Conversely, technical details provided on 5G and associated use cases tend to promote the ability of participants to respond. It is then possible to use the concept of "framing effect" to qualify the influence of the first provided information on the perception of respondents. Indeed, some authors have previously raised the question of framing information on user perceptions [27]–[29].

Our results are different from [30]: Their results show that individuals consistently show lower scores on trust in technology after being exposed to negatively (compared to positively) biased information. Conversely, the positively skewed information does not appear statistically different from the control condition, in which no additional information was



(a) .



(b) .

Fig. 1. Mean and standard deviation on evaluated dimensions according to the experimental condition: purple for low level of information and orange for high level of information

presented. In [18], two variables have positive effects on the intention to use 5G: the perceived usefulness/enjoyment and the personal innovativeness. As [21], our results highlight the importance of frames in perception and technology adoption. But this influence differs because he shows that positive frames (that positively highlighted performance and ease of use of the innovation), by creating specific expectations towards this innovation, can cause rejections within participant evaluations.

Hay et al. (2015) show that Don't Know (DK) responses are correlated with lower education, lower numeracy, lower income, and minority status [31]. Our study also shows that the level of information proposed (frames) also influences the number of DK responses.

Frei (2020) assessed the perception of risk associated with 5G within a population group. It appears that 65 percent

of respondents perceived the risks of 5G as medium to high (responses above 50, within a scale ranging from 0 to 100) [32]. In his Study 2, Frei (2020) shows that objective knowledge about 5G are related inversely to risk perception. Regarding the influence of the level of knowledge on the risks perception towards technology, [33] find similar results to our current study, despite a different experimental protocol. Indeed, among several other psychological factors, the level of Personal knowledge influenced risk perceptions of cell phones, as in our study where the level of information influences similar variables.

Finally, it should be noted that the difference in terms of level of information represents both a quantitative and a qualitative difference. Indeed, beyond the difference in terms of the number of information proposed between the two experimental conditions, there are also differences in terms of types of information. The first conditions "low level of information" is based on a factual description of 5G. The second conditions, also focuses on the characteristics of 5G and its possible applications. Thus, beyond a quantity of information, these details provide insights on the type of information to be provided and its impact on participants' responses,

It might be interesting to replicate this type of study using the prompt method [34], that is to say encouraging people to respond if they checked the DK response. Indeed, the authors compare three methods to treat DK responses in the medical field (exclude this data, recode them at a neutral point on the response scale; recode them to the mean) with the their technique of prompt. It appears that, compared to excluding data related to DKs responses, the prompt improved the data quality and the correlations between constructs.

## V. CONCLUSION

Many debates are currently taking place among the population around the deployment of 5G. Many use cases are mentioned, in particular in terms of connected healthcare. As the technology is not yet accessible to the majority of professionals in the hospital field, it seems necessary to assess their perception and acceptability before use. Many factors seem to influence acceptability and risk perception related to technology. However, few studies focus on acceptability with 5G, especially in the medical field. To the best of our knowledge, few studies show the impact of public policies in terms of information provided on the adoption of new technologies and 5G in particular. Nevertheless, for evidence-based policy-making, experimental data on the impact of the level of information provided on the acceptability of new technologies, and 5G in particular, appear to be essential. This study therefore attempts to answer the question of the impact of users' level of knowledge and of the level of information provided on their perception of 5G. This study highlights the impact of respondents' level of information on their number of Don't Know (DK) responses, related to their ability to position themselves and express a point of view. It appears that participants have more difficulty in

positioning themselves (more DK responses) when they are given low information. In parallel, when the participants know how to position themselves, the level of information does not significantly influence the other factors. These results are essential for the establishment of current public policies in terms of communication, especially in the field of health, where 5G represents significant challenges.

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