



CONNECTION BETWEEN IOT SYSTEM DESIGN AND, HEURISTICS AND COGNITIVE BIASES

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Abstract— This paper highlights that many cognitive biases, or heuristics are prevailing among the solution providers. To find a correlation a survey has been conducted (with the help of many psychological questions) among the industry consultants and IOT solution providers and results are analyzed.

Keywords- Cognitive Bias; Heuristics; Availability; Representativeness; Optimism; Over-certainty or Under-estimation; Loss Aversion; Status Quo Bias; Framing; Temptation; Mindlessness; Spotlight Effect; Priming; Stimulus Response Compatibility; IoT; Assembly Line; Production Line; Manufacturing.

INTRODUCTION

While solving any manufacturing problem by devising a good IOT solution, many consultants or IOT service providers may get influenced by various cognitive biases and may suggest a solution that solves the problem for the time being, but may lead to a long-term issue. If people are aware of such possible biases, then a faulty suggestion can be avoided.

WHAT IS IOT?

The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits, and reduced human exertions. [1]
Usually there are three phases of implementing IOT in any industry-

Phase 1-

Identify the parameters (temperature, humidity, etc..) that are needed to be monitored, and embed devices (sensors etc.) to measure these parameters.

Phase 2-

Collect the data generated through devices in phase-1 and analyze this data to prepare a customized dashboard or report.

Phase 3-

As per the analysis of data in phase-2, send a notification to other devices (pager, mobile, email etc.) to trigger an action.

WHAT ARE HEURISTICS AND BIASES?

A heuristic technique, often called simply a heuristic, is any approach to problem solving, learning, or discovery that employs a practical method, not guaranteed to be optimal, perfect, logical, or rational, but instead sufficient for reaching an immediate goal. Where finding an optimal solution is impossible or impractical, heuristic methods can be used to speed up the process of finding a satisfactory solution. Heuristics can be mental shortcuts that ease the cognitive load of making a decision. Examples that employ heuristics include using a rule of thumb, an educated guess, an intuitive judgment, a guesstimate, stereotyping, profiling, or common sense.[2]

Cognitive Bias - A cognitive bias is a systematic pattern of deviation from norm or rationality in judgment. [3]

Through implementing heuristics people or computers design a process of analysis that they consider is the best suited to any IOT implementation. There are, however, few factors that can affect heuristics, and thus any analysis. Few of these factors are [4]—

1-Availability – the impression of the ordinariness or prominence or commonality of something. Media impact these discernments enormously and can unduly "prime" a group of people. For instance, individuals may trust that there are a bigger number of crimes than suicides, while manslaughters are less than suicides.

2-Representativeness. This propensity is found in the expansion or extrapolation of a little example to create a wrong decision about the master plan, which fills predispositions and generalizations. Once more, the media assume a solid part in stereotyping and separation.

3-Optimism/Over-certainty or Under-estimation. Individuals tend to overestimate rewards and the simplicity of new errands, and under-evaluate costs/costs, timescales, intricacy and trouble, adding to their disregarding, denying or under-assessing or defending danger.

4-Loss Aversion. Individuals tend to esteem something progressively when they have it, then if they don't. This makes latency and the propensity default to inaction. Misfortune abhorrence maintains a strategic distance from hazard.

5-Status Quo Bias. So also, individuals are one-sided toward existing conditions since they fear change, particularly of an indeterminate nature.

6-Framing. Individuals survey choices and settle on choices because of confining, which is the introduction or introduction of data to change its apparent significance or nature. This can involve decisive: if a therapeutic expert spotlight on death rate, individuals tend to put off treatment, while an attention on survival rates tends to expand understanding for treatment, with no adjustment of the real figures.

7-Temptation. Individuals tend to need here and now more than long haul compensate, regardless of whether the qualities are genuine or seen, and they are pulled in to decisions which they see to be simple or that they think will make things less demanding for themselves. The qualities individuals put on various sorts of prizes rely upon a man's conditions and emotions at the time. Promoters carry on an awesome arrangement in this domain.

8-Mindlessness is the inclination for individuals to shape perspectives and choices indiscreetly. Mindlessness is identified with encircling and over-confidence.

9-Self-control Bias- Individuals are regularly mindful that they have some "heuristic" shortcomings, which they may view as negative behavior patterns or shortcomings. They address these by formulating schedules, methodologies, and insurances to ensure themselves, and these discretion techniques turn out to be new heuristic propensities. Following the Herd addresses the "accompanying the group" or "choice by council" heuristics. Media assume a part in this heuristic by helping construct and keep up bunch convictions.

10-Spotlight Effect. Individuals have a tendency to envision that their individual activities and choices are exceptionally perceptible to others; they fear committing an error. This heuristic is frequently misused by the business world and some of the time effectively persuades gatherings of people that specific practices are more typical than they truly are, and that one is strange if not acclimating. For instance, tobacco item position in motion pictures would recommend that a larger number of individuals smoke than is really the case.

11-Priming. Individuals can benefit from outside intervention to approach decisions in a more arranged state, through picturing what a change may resemble, for instance. Network shows, for instance, have highlighted ladies in noticeable positions of authority, for example, Secretary of State or as President, maybe inciting gatherings of people to acknowledge such parts.

12-Stimulus Response Compatibility alludes to whether the look and feel of the correspondence or flag (the boost) coordinates the message that we get or surmise (the reaction) from the correspondence. In legit interchanges, the appearance or feel of something (a sign, words) should enable us to see how to react or draw in with it. Things being what they are, for instance, would a spray painting secured entryway be suitable for a nation club entrance? Or on the other hand does the broad, modest little print in contracts dishearten us from understanding it before we leave all necessary signatures?

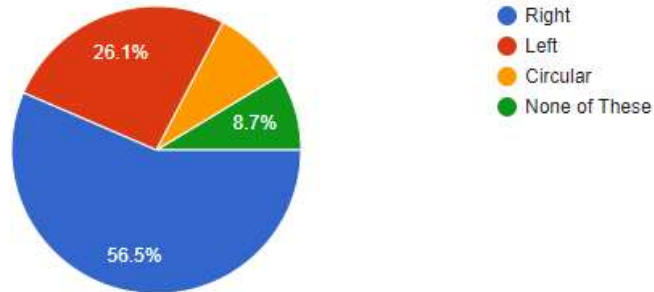
EXPERIMENT TO KNOW HOW IOT ENGINEERS OR CONSULTANTS THINK

A survey [5] [6] has been conducted among more than 20 IoT experts and results are analyzed as below. All the questions are categorized under specific cognitive bias and response to each question has been mentioned with a respective analysis. Survey is presented below -

Availability –

Which direction should the assembly line flow?

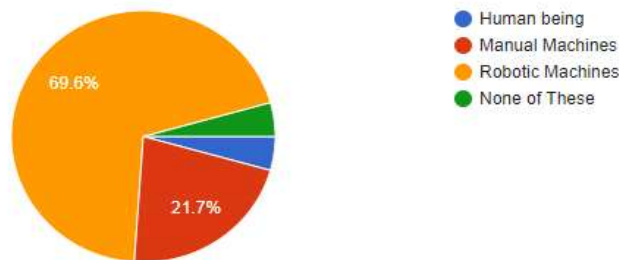
23 responses



Analysis of the result – most of the people haven't thought of up- down, or hyperbolic directions; this may mean that, as most of the times the assembly line is seen by these experts, Availability bias is present among the audience.

What resources could be best to perform manufacturing work?

23 responses

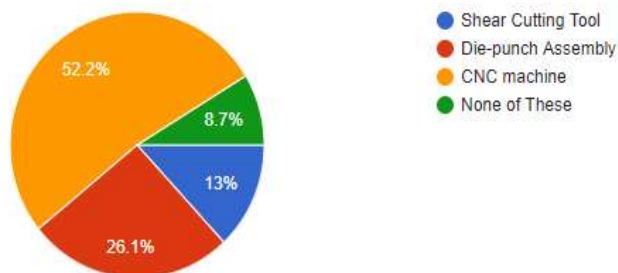


Analysis of the result – most of the people haven't thought of animals as resource; this may mean that, as most of the times media discusses about Robotic machines, Availability bias is present among the audience.

Representativeness.

Which kind of machine would be best to cut a metal sheet in specific shape?

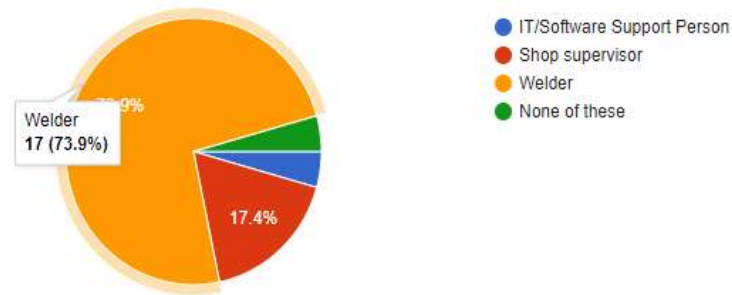
23 responses



Analysis of the result – most of the people haven't thought of X-Ray cutting; this may mean that, as most of the times CNC machines are talked about among these experts, Representativeness bias is present among the audience.

Whom you consider a best person to ask welding related questions?

23 responses

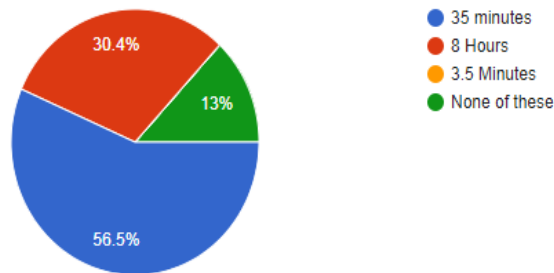


Analysis of the result – most of the people haven't thought of marking option A; this may mean that, as they don't consider IT support person representing a person with a lot of knowledge about welding, Representativeness bias is present among the audience.

Optimism/Over-certainty or Under-estimation.

How much time it will take to assemble a car in usual assembly line?

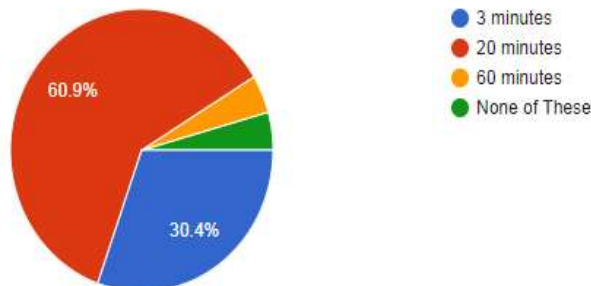
23 responses



Analysis of the result – most of the people haven't thought of time as more than 5 days or less than 60 seconds; this may mean that Optimism/Over-certainty or Under-estimation bias is present among the audience.

How much time it would take to wash a car?

23 responses

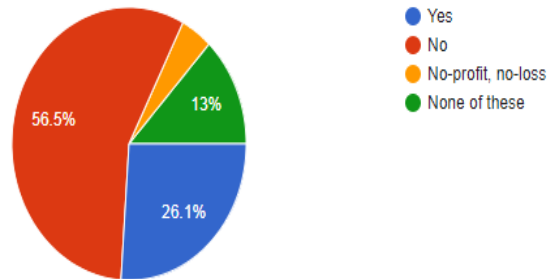


Analysis of the result – most of the people haven't thought of time as more than 1 day or less than 30 seconds; this may mean that Optimism/Over-certainty or Under-estimation bias is present among the audience.

Loss Aversion.

Was it an economic sound decision to move Tata Nano plant from Singur to Sanand, after already investing millions of dollars in the plant?

23 responses

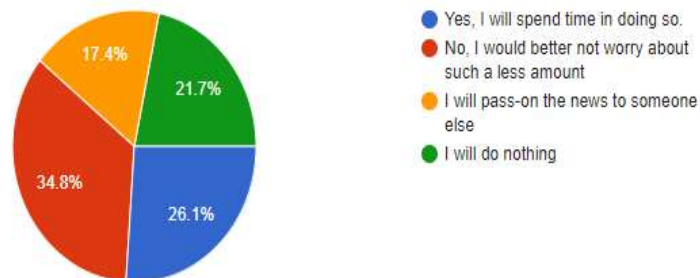


Analysis of the result – most of the people haven't thought of the delay in project, and thus thinking this decision as economic un-sound decision; this may mean that Loss Aversion bias is present among the audience.

Status Quo Bias.

Imagine you will save 2000 INR if you switch your car; will you go to the shop and change your car?

23 responses

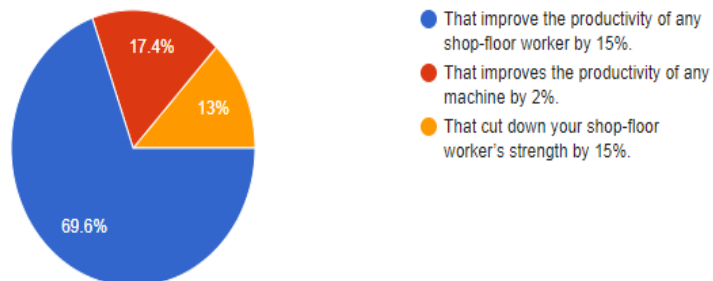


Analysis of the result – most of the people haven't thought of answer option 1st; this may mean that Status Quo Bias is present among the audience.

Framing.

Which IOT system would you recommend to any product assembly line first to any client?

23 responses



Analysis of the result – most consultants have chosen option first or second, while option first and third are almost same; this may mean that Framing has an impact on the audience.

Temptation.

Which IOT system would you recommend to a client who is a very prominent client for you and need to fix a critical issue as soon as possible?

23 responses

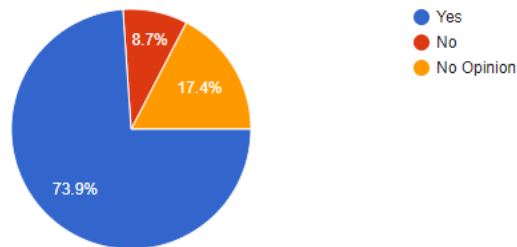


Analysis of the result – most of the consultants would propose short-termed solution - option first, or option third, when a pragmatic, and un-biased approach would be to propose option second; this may mean that Temptation has an impact on the audience.

Mindlessness –

Is the probability of accidents in a very secured machine in assembly line is less than the probability of accidents in an un-secured machine?

23 responses

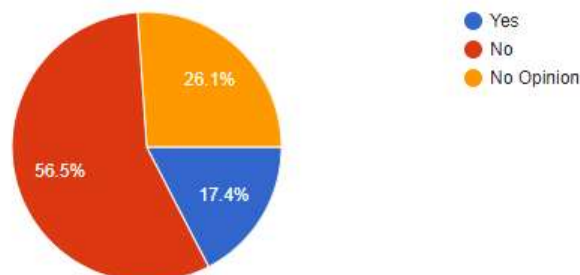


Analysis of the result – Second option seems more practical, but very few people have selected that; this may mean that Mindlessness has an impact on the audience.

Self-control Bias.

Do most of the workers in any plant complain about the sub-optimal performance of a machine, because they want to avoid work?

23 responses

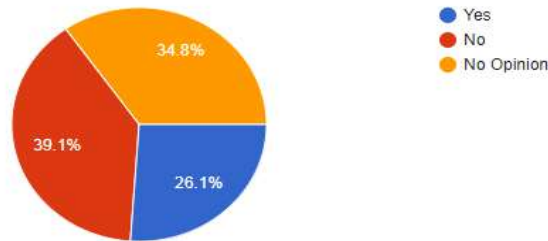


Analysis of the result – most experts opted first option; this may mean Self-control Strategies Heuristics affects the audience.

Spotlight Effect.

Is an IOT consultant who has been appraised by a manufacturing industry magazine better than some other consultant who has not been mentioned anywhere?

23 responses

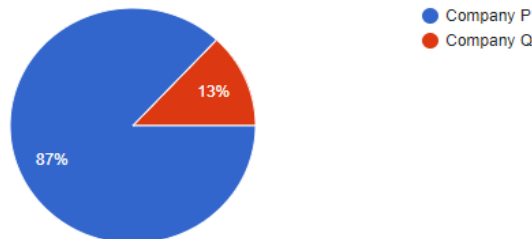


Analysis of the result – a more plausible option could be second option, but very few people have chosen that; this may mean that Spotlight Effect has an impact on the audience.

Priming.

There are two automobiles companies: P – that displays posters of a very good quality luxury car in the outer wall of its manufacturing plant, and Q- that displays no such posters. In the absence of any other information about the companies which company do you think would be better to work with?

23 responses

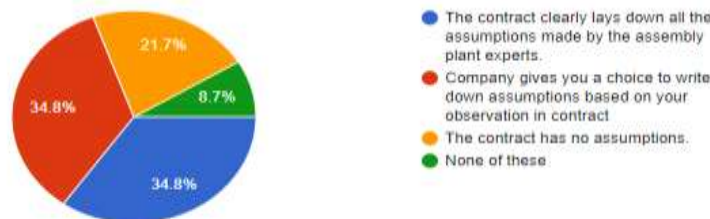


Analysis of the result – most of the experts have chosen company P; this may mean that Priming affects the audience.

Stimulus Response Compatibility

You are an IOT system consultant. Which contract holds more credibility while signing a new vendor engagement with any assembly plant?

23 responses



Analysis of the result – most of the people haven't chosen first option; this may mean that Stimulus Response Compatibility is present among the audience.

HOW HEURISTICS MAY AFFECT IOT IMPLEMENTATION IN MANUFACTURING INDUSTRY

In Phase1 – While deciding what all parameters should be analyzed, people may take sub-optimal decisions. Heuristics categories numbered 1,2, 5,8, and 11 (mentioned above) might affect an effective decision. For example, under category 1(Availability Heuristics), a consultant may not include the vibration sensor in a work-bench of a manufacturing plant, because he hasn't heard or seen anyone analyzing vibrations levels in a work bench in his life. And vibrations might be an important parameter in deciding the lifespan of the work-bench. He may place a sensor at a most approachable position (under the influence of status-quo bias, category 5) in a machine, simply because most of the IoT consultant suggest those position.

In Phase2 – While collecting the data from various sensors of any IoT system an engineer may skip analysis of various parameters under the influence of heuristics categorized as number 3, 4, 7, 9,10. He may suggest that routine manual inspection is not important (as per heuristics of category 3,6,8), while assuming that all the parameters he has considered while designing the system are comprehensive.

In Phase3 – While designing a notification system in this phase of IoT system design, an engineer or a consultant may drop out notifying certain things. Heuristics categorized as number 2, 3, 6, 7, 10, 12 may play a significant role in such a faulty design. For example, an Indian engineer may skip notifying relevant information through a pager system, assuming that all the people have access to softphones, and phones work very well all the times; as the pager is not widely used in India, but used a lot in many developed countries, he may skip relaying the information through pager system.

CONCLUSION

In conclusion, we have seen that various cognitive biases and heuristics impact decision making process of an IoT system consultant, he or she must be aware about such heuristics, especially 12 mentioned above, to avoid any sub-optimal suggestions. A counter system with the help of the knowledge of various heuristics and cognitive biases can be designed to verify the decision-making process. This kind of decision making framework has a lot more work to be done in the future to serve the manufacturing industry in a better manner that machines lack at present.

ABOUT THE AUTHOR



Akash Dwivedi has around 12 year of rich Industry experience in providing Information Technology solution and support to product development process in manufacturing industry, predominantly in automobile sector. His area of work includes Product Life-cycle Management. He has served as a Product Data Management consultant for one of the Big-Three automobile companies of North America, helping it come out of tough recession cycle, during year 2008 to 2014. He has similar tenures of leading various projects for Jaguar Land rover, and McLaren Automobiles, UK. At present he is leading an IT support and development team while working with one of the manufacturing service provider MNC in Pune, India.

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