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Application of TRIZ in Literature; an Algorithm for Systematic Story Writing Based on Mega Problems

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Abstract

Stories have always been an inseparable part of human beings' life. They are a robust instrument which humans exploit to enjoy pleasure and transfer various concepts. Therefore, creating a charming story has always been valuable. Nevertheless, writing a compelling story is arduous and time-consuming. This paper by considering the stories as a realm of encountering characters with problems (bringing stories to the problem-solution space) have used problem solving and structured innovation material to create a systematic algorithm for story writing. The algorithm has been designed based on TRIZ tools and principles. TRIZ, theory of the resolution of invention-related tasks, was introduced by Genrich Altshuller and his colleagues in 1946 in the former USSR. It is a set of tools, methods and strategies developed by years of research and studies of ample patents in order to scrutinize the problems and propose ideal solutions. The proposed algorithm would ease the process of story writing and presents a new specific discipline which the author could systematically write copious stories based on problems. The algorithm includes five certain steps including: 1- identifying a problem and discovering its logic, 2- defining characters and establishing a functional diagram 3-creating story line by exploiting conflict loop, 4- designing climax and terminating the story 5-rewriting and extracting long story from it.

Keywords: TRIZ, structured innovation, storyline, systematically writing

1. Introduction

1.1 About stories

Stories have always been an inseparable part of human beings' life. Every day in all of the world, copious story books are leafed, thousands plays are performed and hundreds of films are screened. From the stories which is narrated for children during bedtime to stories which is told by leaders for their followers to inspire them, all are evidences that story is a robust instrument which humans exploit to enjoy pleasure and transfer various concepts. As a result, creating a charming story has always been valuable. Some believe that story writing is intrinsic affair in

which authors deliberately create them by their feelings and experiences. Others believe authors should know special forms and rules to narrate attractive story. These rules have been mentioned on numerous books about story writing. (Field, 1982) is a well-known book in definition of a structure for story writing. The structure is called three-act structure in which story begins, then challenges increases until the climax point then by solving climax the story terminates. (McKee, 1997) is another popular book for story writing. The book immensely describes details of structures. The concentration of the book is on designing conflict and aesthetic aspects of the story. Besides structures, the book elaborates ideas, problems and characters meticulously. (Mirsadeghi, 1987) is an appropriate book for critical thinking in stories.

A major part of the book has also dedicated to creation of tensions in the story. Most of the books in the subject of story writing teach some rules and tips.; However, Comprehending and applying these rules are usually arduous and time consuming. Furthermore, there is no guarantee that after reading these books people can create stories. In this regard, this paper arises cardinal question, whether it is attainable that instead of rules individuals use some tools for writing stories. In case some distinctive tools are defined for story writing, individuals can create stories by consuming little time and energy.

1.2. Process of story creation

Stories are usually created after four distinctive stages (McKee, 1997; Mirsadeghi, 1987).

1-Finding facts

In this stage the author intentionally or unintentionally begins to store the information from peripheral environment.

2-Ignition the spark

In this level the author come up with an idea and extends it with the previous stage's material (information). In other words, s/he enlarges the idea with the facts which has been established in his/her mind.

3-Imposing a structure

For becoming stunningly attractive, the story needs a distinctive structure. In essence, the author should design diverse challenges which characters should encounter with them.

4- Designing climax

To finish the story, the author increases the quality and quantity of the problems. Therefore, by solving these impediments considerable amount of pleasure is provided for audience. In this while the audience is satisfied for wrapping up the story

If we design some tools instead of every stage, we can pass the stages successfully and create a story. For this purpose, TRIZ can be a breakthrough. TRIZ is a set of tools which has been designed for structured innovation. To put it differently, by this theory people can create innovation systematically. Since stories are also creative task, maybe it is possible that the tools of TRIZ extends to the realm of story writing.

1.3. TRIZ methodology

TRIZ is a systematic way of thinking for solving problems (Savransky, 2000). It is a set of tools, principles, algorithms and strategies developed by

years of research and studies over millions of innovations (Mann & Domb, 1999). This knowledge-based systematic methodology of inventive problem solving was introduced by Genrich Altshuller and his colleagues in 1946 in the former USSR at first. Then it became widespread in the scientific concepts in the world. The theory is usually applied to solve the technical innovations but recent studies have shown that TRIZ principles are also doable to management fields (Mann & Domb, 1999; Retseptor, 2003). In this methodology, Researchers by scrutinizing the wide variety of innovations such as patents elicit their conventional principles which play a key role in their innovations. Next, they employ these principles in developing other systems via especial distinctive tools (GS Altshuller, 1986; Genrich Altshuller, Al'tov, & Altov, 1996; Rantanen & Domb, 2010) This process is also called structured innovation. This paper aim to exploit TRIZ's tools for structuring the stories and designing an algorithm in which people can create stories systematically. In addition, Since TRIZ is a problem-solving method, it considers concepts in space of problem-solution. As a result, the concepts of stories should be transferred to problem-solution space to be analyzed in TRIZ methodology. For this purpose, the stereotype of story is re-defined in this space.

1.4. Stories as a realm of problem solving

Human beings have always been solving their problems any time in his/her life from birth to death. From the toddler who intends to walk by his/her feet to the old man who has been hospitalized and is fighting against his disease, all of them are solving their problems. In essence, the life is a scene of problem solving. Human beings are always encountering new problems and attempting to act accordingly. Thus, if stories have been considered a dramatic model of real lives (Mirsadeghi, 1987), it can be said that they are amazing narrations about encountering among characters and their problems, and surveying their solutions for solving them. In the other words, the stories are the abstract realms which the characters are faced with major and minor challenges and have special interaction with each of them. While the character is tackling the difficulties, the audience is also unintentionally experiencing the same problem and seeking the solution with him/her in the story. This process (facing with problems and making solutions) creates conflict for the audience and entice him/her to follow the story (Forouzanfar, 2018; McKee, 1997; Mirsadeghi, 1987). To put it simply, writing a story is exposing the characters to different kinds of problems and assessing their reactions in the

situation. As a result, if it is possible to design a discipline for bringing a problem and putting some characters against them and then analyzing the characters' reaction for each, it will help to present a special algorithm for writing story lines.

1.5. An algorithm for story writing

As it was discussed, there are four stages for creating a story. If some special tools are employed in order to help author to pass these four phases s/he can create a story. For this purpose, we have chosen some robust tools in which individuals can carry phases effortlessly. An especial algorithm has been yielded by sequence of these tools. This algorithm includes 5 steps as follows: 1- identifying a problem and discovering its logic (which is equal with first stage), 2- defining characters and establishing a functional diagram (which is equal with second stage) 3-creating story line by exploiting conflict loop (which is equal with third stage) 4- designing climax and terminating the story (which is equal with fourth stage) 5-rewriting and extracting long story from it (see figure 1). All of these steps and their tools will be described in the following paragraphs. After that, two stories are unfolded as a case study.

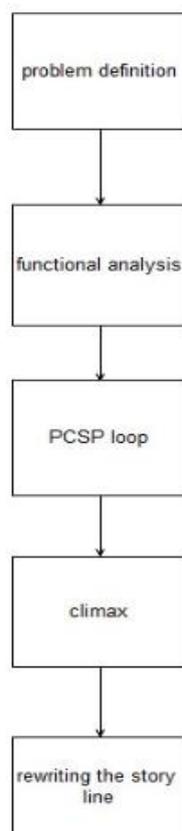


Fig. 1.The levels of the algorithm

2. Algorithm steps explanation

As it was said earlier, the stories were considered as a realm of problem solving. The elements of the story are involved in a problem and they try to clear it up, the idea is that the author should scrutinize a distinctive problem then s/he should create some characters and analyses their interactions in this space. As a result, the proposed algorithm has five steps so that the author can both penetrate the depth of the problem and create a story by TRIZ problem solving tools in an effective manner. Then eventually s/he can terminate it by system theories principles.

2.1. First step: definition of the problem using the cause and consequence diagram

At first, a problem should be chosen and then it should be unfolded. This problem can be any enormous obstacle in human's life like injustice, unemployment, global warming, etc. To perceive the logic of the problem effectively, the cause and consequence diagram is recommended (Auriscchio, Bracewell, & Armstrong, 2013; Lee, Chechurin, & Lenyashin, 2018; Okes, 2019; Pinyayev, 2007; Yuniarto, 2012) Not only is this diagram the most powerful tool for unfolding the cause and effect structure of the problem, but it also is one of the best tools to investigate the problem and its effects in every system such as society (Okes, 2019). One of the considerable advantages of employing this diagram is piercing the depth of the problem incessantly and analyzing the root of the problem (Lee et al., 2018). Figure 2 demonstrates an unfilled form of the diagram. The problem statement is posed in the center of the structure and the causes and consequences are written hierarchically. In the diagram, any causal level is constituted by asking "why" question from previous level so that the diagram is developed gradually (Pinyayev, 2007). The diagram, called logic tree in the root cause analysis methods, is the key tool for perceiving the logic of the problem (Okes, 2019). The main advantageous of the diagram is that the mind of the author unconsciously settles in the space of the problem by fulfilling the cause and consequence diagram, that is the author is discerning the structure of the problem and analyzing it closely.

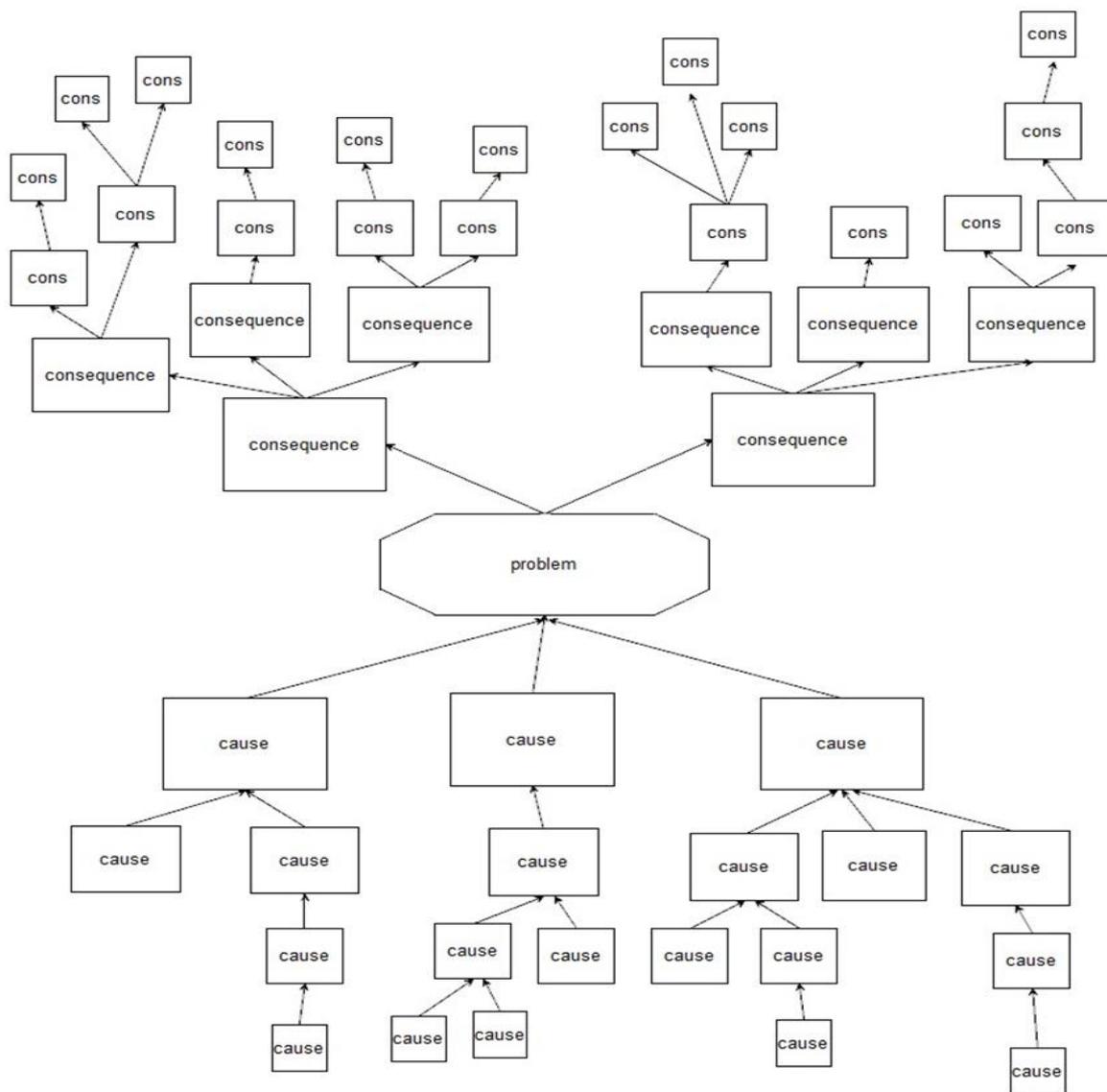
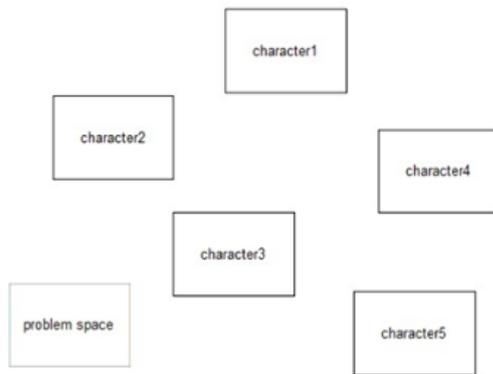


Fig. 2. Problem space

2.2. Second step: functional diagram

When the logic of the problem is determined, the material has been actually prepared for creating the story. Now, the author can create the story line by these materials. To pursue the goal, one of the exceptional tools of TRIZ called functional diagram can be

employed (Abramov, 2015; Aurisicchio et al., 2013; Delgado-Maciel, Cortés-Robles, Alor-Hernández, Alcaráz, & Negny, 2018; Rantanen, Conley, & Domb, 2017). The diagram considers the elements of systems and surveys their functional relationships



2.2.1. Elements

The element means the physical ingredients of the story which either influences other physical ingredients or is influenced by other ingredients in the story (Rantanen & Domb, 2010). These ingredients can be whether human or nonhuman. Moreover, the ingredients should be chosen upon the problem. For instance, if the inequality was selected as a main problem, the elements should be determined around the notion of the problem such as some workers. If we consider some mongers as elements in this problem, the story will not be dramatic since the wealthy mongers cannot probably be exposed by the inequality. If the global warming was chosen as a problem, it would be recommended that the author uses characters related to the sea or farmers since these people are influenced by global warming directly (rising the sea level ruins cities and trades or warming the atmosphere which spoils the crops).

2.2.2. Relationships

Four kinds of functional relationships can be defined between each two elements. These four types are pictured in figure 4 including useful sufficient, harmful, useful insufficient and useful excessive functions (Rantanen et al., 2017). These types will be described by an instance. The useful one means appropriate influence from a character to another one. Consider a lecturer and students where the lecturer's responsibility is teaching just 3 chapters of a book, in case s/he teaches these chapters typically, the functional relationship is useful and normal (it is what is supposed to be) (See figure 5). Such kind of cliché and common relationship is copious in life. However, if the functional relationship between 2 elements is exactly opposite with what is supposed to be, the functional relationship is totally undesired and harmful. For example, the lecturer instead of teaching that 3 defined chapters poses some irrelevant absurd memories which are not proper to students. As a result, not only does not s/he perform the

duties, but also the educator teaches an irrational concept which is harmful (See figure 6). The insufficient functional relationship is a function done in the right way but it is not adequate and complete. Imagine the lecturer has just taught 2 chapters of the book. So, the function is in the right way, but it is insufficient (See figure 7). The last functional relationship is about doing an act more than what should be done. Consider the lecturer teaches 4 chapters instead of 3 ones (see Figure 8). The idea is that some characters should be established in the space of the problem and then the relationships are surveyed among them. Often some ordinary relationships, in the space of the problem (when problem occurs) converts to aberrant one, these abnormal relationships are choices for the starting point of the story. Figure 9 is a sample showing a complete functional diagram.

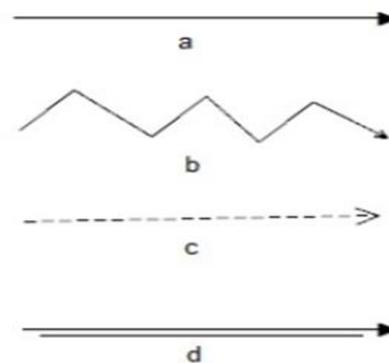


Fig 4. Types of functional relationship between two characters

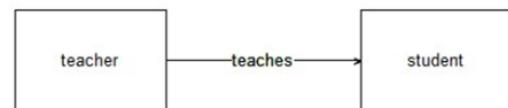


Fig 5. Useful (normal) relationship

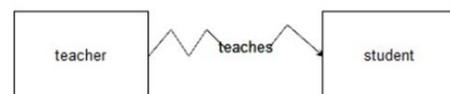


Fig. 6. Harmful relationship

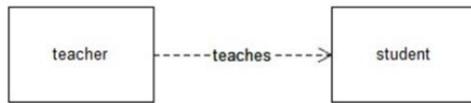


Fig. 7. Harmful relationship

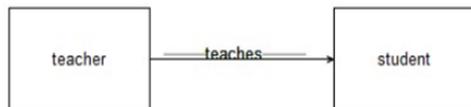


Fig. 8. Excessive function

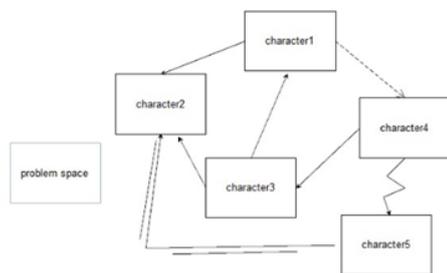


Fig. 9. Completed sample of the functional analysis diagram

2.2.3. Direction of arrows in functional diagram

The direction of arrows in functional diagram is from an influencing element to influenced one (Fey & Rivin, 2005). If the lecturer is teaching students, the teacher will be regarded an influencing element and students are influenced one. Therefore, the direction can be from lecturer to students.

2.3. Third step: conflict loop

Conflict which is the confrontation of different characters or forces through the story is not only the foundation of every narration, but also the most important factor of the story which can persuade audiences to pursue the story until the end (McKee, 1997; Mirsadeghi, 1987). In 2.2, the potentiality for creating the story was determined. Now this potentiality should be turned to the story. Conflict loop could be a suitable tool for this goal. The loop, inspired TRIZ literature (GS Altshuller, 1986; Salamatov & Souchkov, 1999; Savransky, 2000), consists of 4 segments which are: problem, contradiction, solution and progress. The idea is that the character encounters with the special problem, then the contradiction in the problem is appeared, after that a solution is created and the character experiences new phase of the story. In this new realm, another new problem is created then contradiction and solution are followed,

then new other phase is appeared again and this loop continues repeatedly. In case the author tends to terminate the story line, s/he will use the next step which is designing a climax, to finish the story. These 4 parts of conflict loop cause an appeal in the story for the readers. In the following section, each part of these loops will be explained.

2.3.1. Problem

A problem is an abnormal relationship (all sorts of relationship except useful one) which has been created between two characters. A functional diagram is a significant tool to detect the problems but sometimes in the flow of the story the problems appear one by one and there is no need of using it. If the functional relationships in the functional diagram are totally normal, the author can change the situation or characters in the story to create some abnormal functional relationship. Moreover, each problem has some inner contradictions. The author should determine and reveal the contradiction in the problem and make the conflict.

2.3.2. Contradiction

If improving a situation of an element deteriorates a situation of that or another element, a contradiction has been created (Salamatov & Souchkov, 1999). The contradiction can be formulated such as the character 1 should do the act A for the reason B and simultaneously the character 1 should not do the act A for the reason C. every problem inherently has especial contradiction. The author should elicit the contradiction from the problem and obviously indicate to the audience. In essence, s/he should reveal that the character has to do an act and should not do it (The character is in a severe dilemma.). The stronger contradiction makes a stronger conflict. Three kinds of contradiction will be defined in the following part.

2.3.2.1. Administrative contradiction

Administrative contradiction means something should be done in order to avoid an undesirable phenomenon, but it is not determinable how it should be done (Savransky, 2000). For example, consider a young man who understands that her mother has a rare heart disease and she has to be operated and she should have her heart exchanged. Although this operation should be done so fast, their turn for exploiting from organ donation facilities is too late. Thus, the heart should be operated soon to survive the mother, but nobody knows how they can do it fast (An administrative contradiction).

2.3.2.2. Technical contradiction

In technical contradiction, an action is simultaneously useful for some elements and harmful for

some other ones (Savransky, 2000). The amplification of the useful action or the recession of the harmful one for some characters leads to deteriorating the situation of some other characters. In the other words, if an action is done, the situation of some characters improves and the situation of some others worsens. In the anecdote of the ill mother, for instance, the son finds a smuggler group who imports and sells organs of bodies. So then if he does not buy the new heart for his mother, she will die. But if he buys a heart from the smuggler group, another innocent person will be killed. As it is obvious, improving the situation of an element destroys the situation of another element.

2.3.2.3. Physical contradiction

In physical contradiction, a character should execute action A to improve his/her situation and should not do action A or should do anti-A to prevent deteriorating her/himself (Savransky, 2000). That is s/he should and should not do a special action at the same time. In that example, consider the poor boy has decided to buy a heart from the body organ smuggler but just one day before purchasing, he dreams about an innocent African teenager who has been captured and transferred to operations room. So, he extremely feels guilty. As a result, if his mother dies, he cannot forgive himself and if he buys the heart, this guilty feeling will kill him. Hence, he should and should not simultaneously buy a heart. This is a physical contradiction which is done on just one element in the story.

There are two points that should be regarded here. First of all, any type of contradiction can turn to another type (Savransky, 2000). As it is crystal clear in the story of mother's heart, the administrative contradiction was shifted to technical one and then was changed to the physical contradiction. The second point is that the administrative contradiction is the most powerless contradiction (Savransky, 2000). Instead, the physical one is the most powerful type in creating conflict. Therefore, it is highly recommended that the author should not consider a solution for administrative one and leave it to mature enough. The administrative contradiction can gradually convert to technical or physical ones without difficulty and creates stronger conflict. Now this contradiction should be solved, so it needs a solution. In the following section, the solution of the contradiction will be described.

2.3.3. Solution

The author should design a solution to solve the contradiction. This solution can be performed using two methods. First, it can employ a heuristic or creative approach such as exploiting TRIZ and ARIZ

and second, it can involve the character of the story in one spectrum of contradiction (GS Altshuller, 1986; Genrich Altshuller et al., 1996; Al'tshuller, 1999; Bertocelli, Mayer, & Lynass, 2016; Fey & Rivin, 2005; Forouzanfar, 2018; Savransky, 2000). For example, in the story of the sick mother, if the author uses spectrums of contradiction, the boy should choose between his mother and another innocent person; depending on the choice, the story will be continued. But the author could consider TRIZ principles or ARIZ sources to solve the contradiction and choose a solution such as finding some person who claims can heal this disease by special traditional herbal treatment (field sources in ARIZ) or by the use of some artificial smart heart which is invented by the scientists in the field (principle 40 of TRIZ).

2.3.4. Progress

The author had arranged a complete contradiction to entangle the audience in the story and then s/he constructed a solution. So, the audience is looking for the effects of this solution on the problem at this moment. Is this solution enough robust to solve the contradiction? Or would it be a bitter defeat? If the solution is successful, what would be followed?

Progress is a series of events which consequently appear after working out the solution (McKee, 1997). That is, in the progress level, the story line enters new phase and proceeds in this. There are two kinds of progress: static progress and dynamic one. In the dynamic progress, the solution can solve the contradiction so the author outlines a new problem in this new phase of the story and again reveals a new contradiction and designs another solution and comes up with new progress and this goes on. But in the static one, when the solution is appeared and the story proceeds, it will be unfolded that the solution can not clear up the contradiction so the problem is consistent and the contradiction comes back again. While often short stories and classic scenarios for movies exploit static progress more, occasionally novels and series' scenarios use the dynamic progress or the combination of both of them in the outline of their stories. This loop (problem -contradiction-solution-progress) is endlessly repeated until the author intends to terminate the story line. To ending the story designing a climax is crucial.

Table 1. The definition and the responsibilities of the subsystems.

| Name of sub-system | Definition and Responsibility |
|--------------------|--|
| The working tool | The working tool performs the primary function. The main operation fulfills the role of the working tool. |
| The Engine | As a rule ,a working tool is useless without a source of energy and/or engine that enables the working tool to perform its functions. |
| The transmission | transfers the initial energy to the working tool |
| The Control | Regulate and manage other subsystems; make it possible to change energy and substance flows between other subsystems of technique. |
| The Case | Protects system and environment from each other, provides safety , furnishes aesthetics, and maintains the structure and shape of the TS. The shape of the casing is the most important for technique users for comparing with shapes of other major subsystems. |

2.4. Climax

If the author wants to wrap up the story line, s/he needs to design a climax. The climax is the final part of the story which maximum intellectual conflict is fabricated for audience in this spot. At this section, the highest pleasure or pain is transferred to the mind of the audience and satisfies audience for finishing it (McKee, 1997). To design climax, the character or characters of the story should face with enormous and complicated problems from every aspect of the story so that the audience cannot believe the character may overcome the problems and releases him/herself from this tumult. To design climax, the principles of system theory could be beneficial, each system in the world has some special subsystems (Savransky, 2000). These subsystems include working tools, engine, link, controller and case, table 1 describes these 5 subsystems, the idea is that these subsystems should be determined and one or more of them have to be deteriorated so that the character completely encounters serious and complex problems. It is recommended that the solution of problem's climax be the planted information used through the story (Forouzanfar, 2016; McKee, 1997).

2.5. Step 5: extracting long story

In this level, the story line should be rewritten and some features or elements should be either added up or cut so that the story shifts more dramatically and the novels or screenplay can be extracted

3. 2 Case studies

In this section two case studies will be scrutinized. The first one is about creation of a new story based on the proposed algorithm and the second one is about the analysis of an already written story by the suggested model.

3.1 First case study, creation a story based on model

Since the corruption and inefficiency in some parts of Iranian government are one of the controversial problems in Iran; this was chosen to create a story line.

3.1.1 First step: problem definition

Figure 10 demonstrates the simplified cause and effect diagram for the problem (Ali, 2007; Ghaderi, 2009; Maghsoud Najafi, 2012; Majid, 1992).

3.1.2 Second step: functional analysis

The diagram should be included story elements and functional relationships in the space of the problem. Since the problem is about inefficiency and lack of flexibility of government system in solving the people's problems in some public organizations, a novice, who has been hired recently and has not been accustomed to this system, is considered as a first character to demonstrate the inefficiencies in the system. He works at a public office and as a result, his relationship to this space can be appropriate for initiating the story.

As it was mentioned, since the person is a beginner and he has newly been entered the state system, in spite of his other colleagues, not only does he perfectly perform his duties but he also guides all clients enthusiastically. He neither accepts any bribe nor does he commit any illegal deed. However, his colleagues think and do oppositely. So, there is a serious conflict between this novice and veterans. The conflict provokes dispute between him and his coworkers. The first character is named Ehsan. Figure 11 shows the functional diagram of the story.

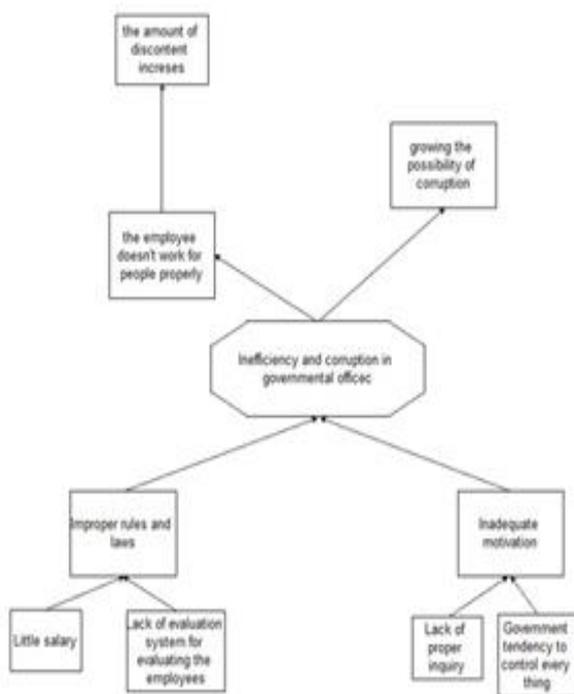


Fig. 10. Cause and consequences diagram

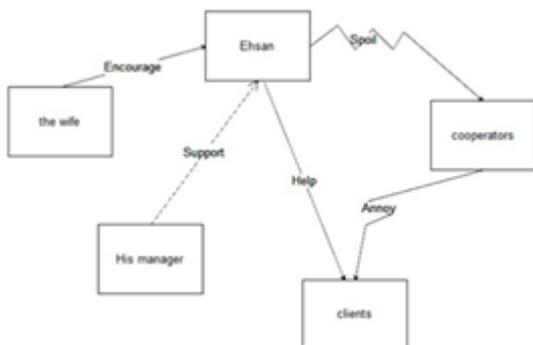


Fig. 11. Functional analysis diagram

3.1.3 Third step: conflict loop

Conflict in a story is created by contradiction, so if the author can both bring a problem for character and explain it as a contradiction, he will create conflict for audience. Next, producing solution is required. The solution can involve the hero of the story into a spectrum of the contradiction or guide him/her to a heuristic and creative one by exploiting TRIZ, ARIZ, etc. Presence of both solid contradiction and desirable solution puts the story into a new phase. Therefore, the author after rambling on this new realm of the story, poses a new problem and repeats this loop.

As mentioned above, the problem in this story is inefficiency and corruption in the public offices. The

novice, named Ehsan, has not been formed in this perverse system. Thus, he has a dispute with his colleagues. The story begins by this problem:

Problem:

Ehsan's coworkers suffer from his performance and are annoyed by his inconsistent behavior. Not only does not he accept any bribe but also, he does his job perfectly. Ehsan's deed is deteriorating the organizational culture.

Technical contradiction:

If Ehsan carries out his duties truly, he won't feel guilty and have clear conscience (+).

If Ehsan carries out his duties truly, his colleagues could be accused of inefficiency (-).

Solution:

One of his colleagues, named Nima, creates a serious quarrel with him through the story and although Ehsan was in the right side, the manager advocates Nima and transfers Ehsan to archive section of the office.

Progress:

The archive section is too chaotic, Ehsan restores discipline to the section. He reforms the process of archiving in the office and someday, while the president of the organization inspects the archive section, he clearly perceives its effective changes, meanwhile, the manager of the section pretends that all of this reformation was for his exceptional performance. So, the president extremely encourages him. Then, in the next week, a special feast for selecting the worthy employee is held and Nima, who did not do his duties at all and had a quarrel with Ehsan, wins the prize of the best employee.

Problem:

Ehsan detests this job and the public office.

Administrative contradiction:

Ehsan should quit this job to gain tranquility (+).

Ehsan should not quit the job since he doesn't find any other appropriate job (-).

Solution:

Note: Since administrative contradiction is the weakest type, it is not recommended to create a solution since it is matured and turned in to other types of contradiction.

Progress

Ehsan seeks a new job but he cannot find one. He suddenly visits one of his old friends who has recently launched a company to import and export the

commodities. Ehsan decides to help him and work in his company. Every day after his official work, he goes to his friend's company and searches about the neighboring international markets. This auxiliary job becomes more and more serious, so Ehsan has to perform some of his occupation during his primary job. As a result, he cannot perform his duties completely, so his boss admonishes him regularly. The boss decides to write an official letter and oust him from his division.

Problem:

Ehsan is losing his main job.

Physical contradiction:

He should hold his job, because his second job is not enough mature to earn adequate money (+).

He should not hold his job, because he neither can bear admonishing his boss nor can he tolerate the air of the office (-).

Solution:

Ehsan finds out his boss owed a huge debt to the bank, and he cannot wipe off easily. So, Ehsan requests a low-interest loan from another bank by his businessman friend for his boss.

Progress:

Suddenly all of the bitter critics is cleared. Hence, he can freely do his private occupations in the working time. Ehsan finds out, he can reach some confidential data about the most important needs of the people and the country via his accesses in archive section. So, he and his friends begin working on it and import commodities which are very crucial for the people; hence, they obtain enormous benefit from this confidential information. The more his second job becomes serious, the more he cuts his duties in the public office to do his second profitable job. Someday, several extremely important files are missed in archive division where the responsibility of the defect assigns to Ehsan. This catastrophe and other critics from his performance prompt the president of the organization to call him and say he is fired.

Problem:

He is being fired.

Physical contradiction:

Ehsan should not hold this job since he neither has any enough time to do this tedious official job nor does he need its low wage (-).

Ehsan should hold the job since he can reach some confidential information which ordinary people cannot obtain it (+).

Solution:

Ehsan realize the president's son is unemployed. So, he offers him a well-paid job, and the son accepts.

Progress:

Not only is he faced with the case of firing, but he also will be chosen as the best employee of the next month. Besides, the president promotes him as a manager.

Note: since there is not any idea to continue the story, another functional diagram is drawn to find some problems in this phase of the story. Figure 12 shows the situation of the elements and their functions. As a result, since one of the considerable problems is still the Ehsan's performance, we can continue the problem in another form.

Continuance of the progress:

Ehsan does not work appropriately in this new position either. So numerous clients complain about flaws and weakness of his performance. Inspection section of the office prepares an extensive report about Ehsan's performance and sends it to the president of organization. The president seriously talks with him, but Ehsan ignores his warnings. The boss of inspection section sends another letter to the president in order to dismiss Ehsan and if the president doesn't act accordingly, he will probably send it to the minister. The president has a great problem.

Problem:

Ehsan's performance

Physical contradiction:

The president should depose Ehsan; otherwise, he should face the consequence which can be a scandal for him in case the minister becomes aware of his inefficiency in managing his employees (+).

The president should not depose Ehsan, because Ehsan will fire his son (-).

Solution:

Ehsan is removed from his job, but he is assigned to supreme adviser of the president.

Progress:

He is now the nearest person to the president. Although he does not almost have specific duty, he intervenes in all of the procedures and now he is the most powerful man in the organization after the president.

3.1.4 Third step: Climax

Figure 13 demonstrates subsystems of the story based on the information revealed up to now. To design a climax, the author should ruin all or

some pieces of these subsystems so that the air of the story becomes complicated, then the audience could not imagine a solution for such a situation. Thus, according to figure 13 it can be said:

The president shifts (destroying casing) and one of the organization's manager promotes to the president. The new guy totally knows Ehsan's precedent. So, at first, he decides to suspend him from his position (destroying link) and demands from inspection section to prepare another comprehensive report about him. This news spreads in the organization. Therefore, organization's managers prevent communicating with Ehsan (destroying engine). So, he loses his credit and information sources. Ehsan requests resigning his job, but the president does not accept and says he should wait until the end of investigations. Some days later, Ehsan hears a large impeachment is preparing for him. He is really messed up (destroying his control). As a result, he meets with a major accident in the street and his hand is broken (destroying working tool). He is hospitalized immediately.

Solution for climax

As it was said, planted information mentioned in the story can be applied as the solution of the climax. So, it can be mentioned that in the hospital, the manager of archive section (whom Ehsan had prepared a loan for) comes to visit Ehsan. He says Ehsan's situation is too awful, but he can help him. He says he has found some documents in the old files which can prove that the new president has been involved in a corruption several years ago. Ehsan obtains the data then he reveals them to both newspapers and lawmakers. The president is fired and Ehsan promotes as the president. Ehsan immediately designates the archive manager to his vice president.

Some years later:

One of the lawmakers is speaking in the Parliament, he yells: the proposal minister has been a government official since 23 years ago, so how could he have created this wealth? How could he have accumulated 90 million dollars? Then Ehsan aged and has gray hairs, begins to speak: it is a big lie. I do not have enough money to pay the expenses of my son's college, I just have an old car and a rental home. An old man among lawmakers stands (he is a man who was the manager of the archive section and helped Ehsan.) and shouts he is totally right. I have never seen such an honest man in my life.

3.2 Analysis of the story

This story line was systematically created by the algorithm. As it is obvious, the author can complete the structure of the algorithm by his creativity;

however, the special way for channeling the story has been prepared. In this sample, the functional diagram was used twice, but if it will be essential and in the lack of idea, the author can exploit more functional diagrams to trigger his mind for new ideas. The story has 5 conflict loops. In the second loop, the administrative contradiction was used and it was left to be mature. We used just a few characters and loops to create a short story but it could be more if the author tends to develop it. For example, Ehsan's wife or his son can be entered in the functional diagram and create new problems. In the climax, all of the five subsystems were both detected and destroyed to constitute a climax and then it was solved by the planted information.

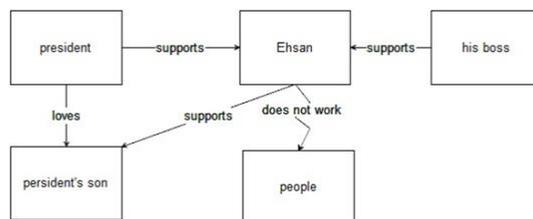


Fig. 12. Functional diagram of Ehsan's situation

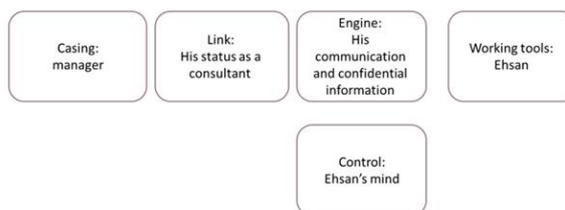


Fig. 13. Subsystems of Ehsan's situation

3.3 Second case study: Analysis of 12 years a slave

If the proposed model is true, it should accommodate with already written stories properly. Thus, in the second case study, a famous story about slavery period in USA will be analyzed according to the suggested model.

Twelve Years a Slave is an 1853 memoir and slave narrative by American Solomon Northup as told to and edited by David Wilson. Steve McQueen directed a movie based on the book in 2013. The movie received widespread critical praise and was named the best film of 2013 by several media outlets and critics. The film was awarded the Golden Globe Award. British Academy of Film and Television Arts recognized it with the Best Film. 12 Years a Slave was later named the 44th greatest film since 2000 in a BBC poll of 177 critics (contributors, 2020, December 29).

In the following, the summary of the story will be explained at first, then the analysis of the story according to the algorithm will be described.

3.3.1 the summary of the story

Mr. Solomon was born a freeman in New York. He is married with two children and is an accomplished violinist. Two men entice him to Washington, D.C., with the promise of a high-paid job playing music in a circus of sorts. They drug him and deliver him to a slave pen, from which he is shipped to New Orleans and sold by a slave trader as a runaway slave named Platt to a relatively kind plantation owner, Ford. Mr. Solomon incurs the enmity of Ford's carpenter. He arranges to have Mr. Solomon lynched, but Ford stops the lynching. Because of carpenter's hostility, Ford sells Mr. Solomon to, a particularly vicious and alcoholic plantation owner (Bauer, 2018).

On Epps's plantation, Mr. Solomon becomes friends with another slave, Patsey. Epps pays particular attention to Patsey, often expressing his obsession by raping her. At one point, Epps decides that Patsey has earned punishment, and he forces Mr. Solomon to whip her. Solomon's repeated attempts to regain his freedom finally yield success when Bass, a Canadian abolitionist working as a hired hand for Epps, is convinced that Mr. Solomon's story is true and alerts the authorities in Solomon's hometown of Saratoga Springs, New York. A sheriff arrives and he is released (Bauer, 2018).

3.3.2 Analysis of the story according to the proposed model

The model includes five steps for creating an outline for the story. The first and second step is for detecting an idea and fostering it. Since this story has already existed, we cannot investigate these steps which were cause and effect and functional diagrams. In the following, conflict loop, climax and designing its solution will be demonstrated.

3.3.2.1 Conflict loop analysis

The story begins when a free black musician man, Mr. Solomon, is kidnapped (SparkNotes).

Problem:

Mr. Solomon awakens he finds himself in chains as a slave.

Administrative Contradiction:

Mr. Solomon have to be freed since he is not slave (+).

Mr. Solomon doesn't know how to free himself (-).

Solution:

He clearly explains who he is and talks about his freedom for the people who have captured him.

Progress:

As a response he is subjected to torture to accept he is not a freeman.

Problem:

He is receiving harsh punishment

Physical contradiction:

He has to accept he is a slave to escape the punishment (+).

He does not have to accept being slave since he would deny his freedom (-).

Solution:

While He does not accept being a slave inherently, he would not say anything about his freedom any more.

Note: as it is obvious, the solution which has been chosen is not based on the spectrum of the contradiction. as mentioned earlier, these types of solutions are creative solution.

Progress:

Mr. Solomon is not alone, there are some other people who have been stolen. One night, they are woken up in the middle of the night and made to board a steamboat to be sold in the other state.

Problem:

Mr. Solomon is too dismal and downhearted he cannot accept the situation.

Administrative contradiction:

Mr. Solomon should not be in a slave position since he is a free man (+).

Mr. Solomon should be in this position since he doesn't know how he can change the situation (-).

Note: since there is an administrative here, there is not considered a robust solution to solve it.

Progress:

On the boat, Solomon befriends a man, who, like them, has also been kidnapped and torn from freedom. The man works out a plan for escape. Whereas, the escape plan is so valuable, it is too hard to do it. After a while, the man is killed by masters. Others find out if they dream about escaping the only thing, they will be encountered is death. The passengers of the ship disembark in the port. Meanwhile, one of the slave's owners who had found his slave

has been stolen, finds the ship and liberates his slave by enforcing the law.

Note: liberation of the slave by exploiting the law is the planted information which will be used in the future for designing a solution in the climax.

Continuation of the progress:

A slave monger prepares slaves for auction. He names Mr. Solomon, Platt. From now on, Mr. Solomon becomes Platt and begins a new life. Luckily in the auction, Platt is sold to a kindly, wealthy gentleman named William Ford, an esteemed Baptist preacher from the Red River region of Louisiana. Platt and Ford travel to the Great Pine Woods to Ford's home. Ford proves to be a compassionate, gentle owner, and treats his slaves like his own children. He reads the Bible to them and teaches them to trust in God, who loves all children, free or enslaved. Platt decides to be a gentle slave for Ford to make more time for seeking a solution for his trouble. However, he has serious problems with Ford's carpenter. He forces him to labor tirelessly and is never pleased with Platt's work. On one occasion, the carpenter tries to whip Platt for using the wrong nails. Platt tackles to the ground and whips the master. As a result, He is severely threatened to death by a carpenter. He knows the carpenter will kill him.

Problem:

Platt will be assassinated soon if he stays there.

Physical contradiction:

Platt have to leave there since he will be killed if he stays there (+).

Platt doesn't have to leave there. Since by escaping, he will be followed by Ford's people and carpenter and they will definitely kill him (-).

Solution:

Platt waits.

Progress:

The carpenter and the two men come and prepare to execute Platt. When they slip the noose around Platt's neck and begin to drag him toward a tree, one of Ford's people runs out, pistol in each hand, and forces the men to leave the property. Nonetheless, it is not the end. Since the carpenter has been publicly insulted, he cannot forget the Platt.

Problem:

The carpenter is seeking for an opportunity to kill Platt.

Technical contradiction:

Mr. Ford should let carpenter to kill Platt for bringing about peace in the farm (+).

Mr. Ford does not have to let the carpenter to kill Platt, since Platt does not deserve such a harsh punishment. Besides, he paid much money for owning him (-).

Solution:

He sells Platt to another masters.

Progress:

Although Platt is initially relieved to be under new ownership, he quickly discovers that his new master, Epps, is much worse. Epps is a gruff, uneducated man who frequently overindulges in alcohol. He is a violent master, as he makes all of his slaves live in constant fear and prides himself on his ability to "break" slaves. One of Epps' slaves, a young girl named Patsey, receives particularly inhumane treatment. Epps frequently rapes Patsey.

Problem:

Platt is dismal and downhearted he cannot accept the condition.

Administrative contradiction:

Platt should not be in a slave position since he is a real free man (+).

Platt should be in this position since he cannot change the situation (-).

Progress:

After ages, a white worker who is not a slave comes to the farm to earn daily wage for working in the plantation. Platt finds a white worker and befriends him. A while later, Platt urges him to secretly forward a letter to his relatives. He accepts and vows to stealthily post the letter. However, he rapidly reveals the story for EPPS. The master goes to Platt with a knife and asks him for an explanation.

Problem:

The Platt's secret has been disclosed

Physical contradiction:

Platt have to confess since everything has been revealed.

Platt does not have to confess, since he would be killed.

Solution:

Platt says that the worker is a liar. Since he desperately needs money, he is lying to make EEPS hire him as an administrator of slaves.

Note: this is a creative solution. Actually, Platt has confessed (talked about the story) and in the same time does not have confessed (did not say the truth).

Progress:

EEPS is conceived so he disengages Platt. Some while after, a Canadian contractor named Bass comes to the farm to undertake a new construction project and Platt is also ordered to help. Bass is a middle-aged man with strong anti-slavery opinions.

Note:

This information is planted here to be used in designing a solution for the climax.

3.3.2.2 Design

Working tools:

Platt's body and abilities to work as a slave

Engine:

The hope of being free one day

Link:

Nothing

Casing:

A supposition that if you are a gentle slave you will have more power and respect. If unquestioningly obey the master, you would have more comfortable slavery life

Note:

For designing climax, the author destroys the casing at first. For this purpose, one of the best EEPS'slaves is going to be severely whipped until death. Further, the author will destroy the only hope of the Platt to finalize the climax.

Progress:

As in aforesaid, EPPS has a smart slave named Pasty, one of the best slaves of the farm. She also looks pretty. Epps frequently rapes Patsey. One day, EPPS cannot find her. Convinced that Patsey is secretly visiting a white man who lives nearby, Epps flies into a jealous rage. When the Pasty comes back

to the farm. He ties Patsey's wrists and ankles. Brandishing his thickest whip, Epps forces Platt to beat Patsey.

Problem:

Platt has to whip Pasty

Physical contradiction:

Platt has to whip the Pasty since this is the master's command (+).

Platt doesn't have to whip the pasty since not only is she innocent but she is his friend (-).

Solution:

Platt gently whip the Pasty.

Note: the solution is creative one.

Progress:

Epps watches Platt's whipping, snatches the whip and tortures Patsey with even more forceful blows. He stops once Patsey is disfigured and nearly dead. From then on, Patsey's mental and physical health declined rapidly. Platt is pretty brokenhearted. He breaks his Violin. He is not able to bear the situation any more (destroying casing).

After a while, when he was working for Canadian contractor, Bass, he explains his kidnapping and wishes to escape. Risking his safety for Platt, Bass promises to write letters to Platt's contacts in New York. Several months go by without a reply, Platt feels dejected (destroying engine).

Final solution:

After ages, while Platt is toiling in the cotton fields, he sees a carriage rumbling toward the property. A sheriff and another man step out and ask which slave is named Platt. Coming forward, Platt is confused as to what the sheriff wants from him but is immediately overjoyed at the sight of his friend Northup. The sheriff and Northup settle Platt's release with Epps, who is furious and threatens to kill whoever sent the letter to Perry and Parker. Platt's release is finalized in court the following day, and Platt departs with Northup.

3.4 Analysis of the structure

The story is a biography which includes some administrative, physical and technical contradictions. The main problem which the story had been created based on, is the kidnapping of free black people and selling them as slaves. The minor problem of the story was also about the severity of the slave's life. The story has a great administrative contradiction

which is: Mr. Solomon should not be in a slave position since he is a free man and simultaneously, he should be in this position since he doesn't know how he can change the situation. The author has carefully designed the story in the manner in which he regularly demonstrates this contradiction. All other contradictions containing technical and physical ones occur in this main contradiction. As the main contradiction constantly duplicated, it has a static structure. Other contradictions which solve during the flow of the story carry dynamic form. In the climax design two parts of subsystems are destroyed and then eventually the solution based on planted information comes and clears up the main contradiction.

4. Conclusion

TRIZ has always been a useful tool which helps in solving challenges in managerial and technical issues. The theory had provided a systematic method for solving technical and managerial problems and proposing creative solutions systematically. Since stories also are scenes of problem solving, the authors can exploit problem solving concepts to design stories. This paper applied TRIZ methodology to design an algorithm for creating story systematically by considering stories as a narration of character's problems. In the other word, the paper proved problem solving material can be useful in story writing.

Moreover, this study provided useful structure which authors can create story via some easy effective tools systematically. Therefore, individuals, especially beginners, can exploit painless simple systematic structure for creating stories instead of copious confusing rules and tips which has been discussed in classic books. The structure consists of some distinctive tools. The cause and consequent diagram used in this algorithm have been inspired from logic tree in root cause analysis which enormously helps author to find the logic of the problem. The functional diagram obtained from TRIZ literature is a suitable driver to scrutinize the situation of characters and identify a problem for creating the conflict. The conflict loop was designed based on TRIZ ideas in recognizing and solving problems and it develops the constitution of the story. Approaches of system theories in defining subsystems was another extremely helpful tool for making enormous and insoluble problem to design a climax.

5. Future researches

The algorithm which has been created according to TRIZ tools can ease the process of story writing. Individuals by identifying a problem and accurately following the algorithm can write outlines of stories without wasting time. Moreover, since the algorithm has been designed in problem-solution space, realizing and following the direction of the process is fairly more straightforward than classical ways of teaching story writing. In addition, if the writer is familiar with TRIZ theory, s/he would benefit copious TRIZ' tools and principles to organize creative solutions for produced problems. However, the algorithm has some flaws. First of all, the author can only create contradiction-based stories. There are ample stories which does not have fundamental contradictions. Thus, the proposed algorithm does not meet their requirements. In addition, the authors would not be able to write all genres of stories. For instance, the proposed algorithm is not helpful for creating comic stories. As a result, Future researches in this topic should concentrate on modifying the algorithm in order to clear up the flaws. Moreover, the authors of the paper are going to assess the effectiveness of the algorithm on the learning story-writing process for the inclusive range of pupils including literature and engineering students in their future research.

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Managing change towards Industry 4.0: How organizations design and implement Industry 4.0 projects

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Abstract

The paper aims to examine how best or new practices of Change Management (“CM”) influence the implementation of Industry 4.0 paradigm. Due to the novelty of the phenomenon and to the deep investigation required to grasp the relationship between Change Management in industrial contexts, a multiple case study analysis has been performed: Industry 4.0 (“I4.0”) projects of five different companies operating in the North of Italy have been considered. In addition, an expert consultant has been interviewed and insights have been integrated to validate assumptions and results coming from the case studies. The authors provide detailed empirical evidence on the connection and use of some CM practices throughout the implementation of I4.0. Moreover, the study finds out some managerial implications that could facilitate adoption of this paradigm such as project governance, role of Human Resources (“HR”) function, enabling factors and resistances management. This study puts light on how CM practices can influence the outcome of I4.0 implementation bringing real-world observations with a clear framework connecting the two fields, as few studies have done before.

Keywords: Change management, Industry 4.0, Industry 4.0 implementation case studies, Industrial systemic innovation, Smart Manufacturing change management

1. Introduction

The world of factories is undergoing a profound transformation determined by a paradigm shift that sees the fusion of the real world of productive resources and the digital world. It is a moment of discontinuity, often associated with a fourth industrial revolution, capable of substantially modifying the methods of design, organization and management of production sites. This industrial revolution, or Industry 4.0, envisages the digital transformation of the industrial system, thanks to a combination of technologies that make it possible to create an ecosystem of factories, machines and intelligent objects capable of dialoguing not only with each other, but also with the surrounding environment.

Innovation 4.0 is based on the development of awareness of the prospects that the company intends to achieve in its process of digital transformation, which cannot overlook the importance of a crosscutting approach that takes into account the impacts of change within the organizational processes of the company. For this reason, the topic of this dissertation is focused on how firms deal with change management during Industry 4.0 implementation, a new subject not yet formalized in detail. Starting from the literature state of the art, that still lacks contributions over many Industry 4.0 change

management aspects, this research paper intends to make a step further towards a systematic review of the good practices that come from real-world cases. The aim is helping firms and practitioners, to better design and address the organizational change entailed in Industry 4.0 implementation.

2. Literature Review

In order to grasp the peculiarities of the two subjects and the ones at their intersection, a deep analysis of the literature (both academic and grey) has been carried out, trying to portray the state of the art of Industry 4.0 Change Management (“I4.0 CM”) approach.

2.1 Industry 4.0

The term Industry 4.0 has been used for the first time at the Hannover industrial fair in 2011, in which the German government decided to start a funding campaign in favor to the private sector and the university hubs in order to exploit the new emerging technologies, particularly their applications into the manufacturing field (Stary & Neubauer, 2016). Industry 4.0 goes far beyond the simple digitalization or digitization of factories;

it builds upon those concepts which may be simply interpreted as technological prerequisites of the new manufacturing paradigm.

In recent years, Researchers and practitioners proposed several frameworks describing enabling technologies for the implementation of the Industry 4.0 paradigm. For instance, the Italian government, within the “Piano Industria 4.0” governmental initiative, has identified 9 enabling technologies to launch a smart manufacturing initiative (MISE, 2016), or more recently, some authors managed to create a more complete framework containing 13 different technologies and technological trends as enablers (Ghobakhloo, 2018). Another type of classification largely adopted in Italy is the one provided by Politecnico of Milano (Osservatori Digital Innovation, 2016). This model identifies 6 smart technologies that can be grouped together in two distinctive groups: on one side, there are three technologies nearer to the Information Technology side (Industrial Internet of Things (“IoT”), Industrial Analytics & Cloud Manufacturing); on the other, there are three technologies with a higher proximity to the Operation Technology (Advanced Human-Machine Interface, Advanced Automation & Additive Manufacturing). Most importantly, the common trait is that adopting one or more innovative technologies is not enough to implement Industry 4.0 paradigm: a systemic perspective is required, meaning that companies need to pursue a larger and larger interconnection that enables better planning, monitoring and decision-making, increasing the general competitive level and the value added by the firm. In other words, firms should undergo through a pervasive change process.

2.2 Change Management

Nowadays, we hear more and more talks about organizational change. By surfing the Internet, it is possible to see how many texts, projects and training courses are on organizational change topics. However, what is organizational change? We can define the organizational change as “the process through which an organization modifies its present condition by identifying new arrangements for its value creation system, in order to increase its effectiveness” (Bartezzaghi, 2010). In an ever-evolving environment like today, organizations must be able to adapt, change and govern changes that affect their architecture, procedures, systems, roles and behaviors. There are many pressures coming from the surrounding environment that force companies to change. Those forces can be market globalization, competition, technological innovation, mergers and acquisitions, and

so forth. In order to be able to anticipate proactively the changes required by the external context, companies must develop and empower change management practices. Bartezzaghi defines the change management as “a systematic approach to deal with change in an organization as a whole and in the individuals, who make it up. It consists of a set of processes, tools and techniques aimed at preparing the company for change, planning and controlling change, and making change effective in the organizational context” (Bartezzaghi, 2010).

Since the organizational change is a complex issue concerning procedures, processes, structures, individuals and groups, planning and its implementation can lead to many different directions, paths and typologies. In particular, two main classification dimensions affecting change characteristics are present in the literature and are summarized in the Table 1 below:

Table 1. Relationship between intensity and magnitude of change (Bartezzaghi, 2010)

| | <i>Incremental change</i> | <i>Radical change</i> |
|------------------------------------|---|--|
| <i>Holistic change</i> | Adjustment of the organizational and management solutions adopted | Introduction of new organizational and management models throughout the organization |
| <i>Limited (or focused) change</i> | Improvement of management methods, techniques and tools | Introduction of new organizational and management models as part of a business process |

Over the years, literature developed many theories that lead to more or less effective models to deal with change management, but Lewin and Kotter models have been the most acknowledged. The former identified three steps (unfreezing, changing and freezing) that a firm needs to undertake when facing a change (Lewin, 1951). The latter, starting from the observation of typical errors of change projects, has pinpointed actions and strategies to undertake to best deal with each of the 8 phases of the identified change. Those phases are: establish a sense of urgency, form a strong guiding coalition, create a vision, communicate the vision, provide the necessary empower to implement the vision, plan and create short-term achievements, consolidate the improvements and produce more change, institutionalize the change (Kotter, 1996).

In a historical period as complex as today, in which competitiveness is increasingly high and technological change proceeds so quickly, working towards change as

a cultural and business phenomenon is essential to ensure the competitiveness of companies' ecosystems. However, even if change management discipline is quite old, its diffusion is not capillary yet.

2.3 Industry 4.0 and Change Management

What emerges from the real world is a clear trend: firms are more and more implementing projects related to a pervasive digitalization (Assochange, 2018). Research defines Digitalization as the most diffused driver for change and, at the same time, impacts over many different areas. When digitalization relates to manufacturing and operational area of a firm, the organization is dealing with an Industry 4.0 change. This kind of change process has many peculiarities: usually, it is a large-scale technological transformation, thus requesting the involvement of many different functions of the company as the impact is diffused (McKinsey, 2018). This kind of projects often relies on some kind of external collaborations within the business environment of the firm or may disruptively influence it (BCG, 2019): new jobs and new roles are created, while others are changed or no longer exist. For these reasons, the type of culture and the role of people are two factors with a peculiar high relevance in this context, much more than in others (BCG, 2018). All those points, identified inside the grey literature, highlights the need of managing this type of change with a new approach, different from the traditional one.

Since no practitioner has already proposed a specific Industry 4.0 implementations change management methodology, the purpose of this research paper will be precisely to highlight the particularities of change management in this context. In recent years, academicians have identified some gaps, trying to fill them by conducting researches over this topic. In particular, the actual state of the art regarding both new practices of change management and its relationship with the Industry 4.0 reality is grouped under nine macro-themes in the following Table 2:

Table 2. Literature review main findings

| <i>Macro theme</i> | <i>Main findings</i> | <i>References</i> |
|---------------------------|--|---|
| Project Management ("PM") | PM and CM are becoming more and more integrated since PM is bringing new type of tools and is fostering agility inside CM. This trend is relevant in projects like I4.0, where radical innovations aim at introducing technologies, requiring a change in the way of working. | (Hornstein,2015), (Macke et al., 2016), (Kurdve et al., 2016), (Sjorgen et al., 2018) |
| Digitalization | Digitalization is changing three main aspects of CM: training, communication and monitoring. This is mainly true in I4.0 where it is plenty of data and technology is mature. | (Chrysolouris et al., 2013), (Niess & Duhamel, 2018), (Da Veiga, 2018), (Akarsu et al., 2018) |
| Communication | Verbal and non-verbal communication during the three phases (preparation, implementation and consolidation) has changed thanks to new digital tools. Since many I4.0 projects launches are followed by introduction of digital tools on the shop floor, they enable new practices also in the change management. | (Merriam -Webster, 2019), (Hermann et al., 2016), (Will & Pies, 2018), (Akarsu et al., 2018), (Hemme et al., 2018), (Niess & Duhamel, 2018) |
| Strategy and Management | The strategy definition needs to be systemic to reach financial and other type of goals; top management needs to act proactively and as a role model during the process, particularly in case of smart manufacturing radical changes. | (Agostini & Filippini, 2019), (Ghobakhloo, 2018), (Schneider, 2018), (Qin et al., 2016), (Stary & Neubauer, 2016) |

| | | |
|----------------------------|--|--|
| Lead Team | The lead team composition and governance can have a high impact on results for I4.0 projects due to their extension and complexity (where many different parts of the processes are addressed). | (Shams et al., 2017), (Macke, et al., 2016), (McKinsey, 2018), (Koch et al., 2016) |
| Competences and Skills | Several types of new competences needed in these processes and firms, to fill possible gaps in order to exploit fully the technologies offered by I4.0 paradigm and to be ready for the change, should define an accurate strategy. | (Cagliano et al., 2019), (Secchi & Rossi, 2018), (Hecklau et al., 2016), (Ghobakhloo, 2018), (Liboni et al., 2019) |
| Culture and Resources | Organizational culture has a great effect over I4.0 changes with new introduced ways of working; the actual and perceived workload could have a strong impact over results of the processes because of the efforts required. | (Sony & Naik, 2019), (Toytari et al., 2018), (Mohelska & Sokolova, 2018), (O'Connor et al., 2018) |
| Peers and bottom-up Impact | Different identified effects driven by bottom-level workers involvement: correlations with resistances, generation of use cases and possibility of timely adjustments. In case of projects that introduces new ways of working, this becomes fundamental to smooth any obstacles and reach quick wins. | (Akarsu et al., 2018), (Goltz, 2018), (Niess & Duhamel, 2018), (Schneider, 2018), (Agostini & Filippini, 2019) |
| Maturity | The importance and the spreading of the new tools to assess technological maturity and general competences of firms is increasing in I4.0 projects due to their high-level technological knowledge requirements. | (Rajnai & Kocsis, 2018), (Sheen & Yang, 2018), (Schumacher et al., 2016) (Mittal et al., 2018), |

3. Research Questions and Framework

Industry 4.0 Change Management is at the intersection of the two topics illustrated before. Due to the newness of the former topic and to the partial diffusion of the latter, different gaps in the literature can be found, pointing out areas in which performing future researches, as suggested by many authors. It is possible to summarize these gaps around three main topics:

- Change process: it is urgent to identify and define the key steps inside the change process (Schneider, 2018). In particular, the steps where there is the highest uncertainty and need to expand the actual knowledge are 4: lead team formation (Toytari, et al., 2018), top management approach (Sony & Naik, 2018), communication (Will & Pies, 2018) and change management advancements (Niess & Duhamel, 2018);

- Contextual and characterizing factors: there is still a lot of knowledge to develop around the correlations between outcomes and some contextual factors (inside and outside the firm) in order to understand the best conditions to implement these technological projects (Da Veiga, 2018). In particular, the unstudied internal factors concern the employees and competences management, the firm technological and organizational maturity (Ghobakhloo, 2018), the centralization level of decisional process (Hermann et al., 2016), the saturation of resources and the firm culture. On the other hand, the unstudied external factors deal with the environmental momentum, the national culture (Sheen & Yang, 2018), the industry nature and the type of approach for the implementation of the project in case this is settled outside the limits of the company (Sony & Naik, 2018);

- Industry 4.0 distinctive elements: some general high-level roadmaps have been developed, but a specific roadmap for firms with some distinctive traits is missing (for instance, SMEs which have many more constraints in comparison with the large ones) (Mittal et al., 2018). Finally, the effects over the firm structure (at both macro and micro level) are still unclear (Liboni et al., 2019).

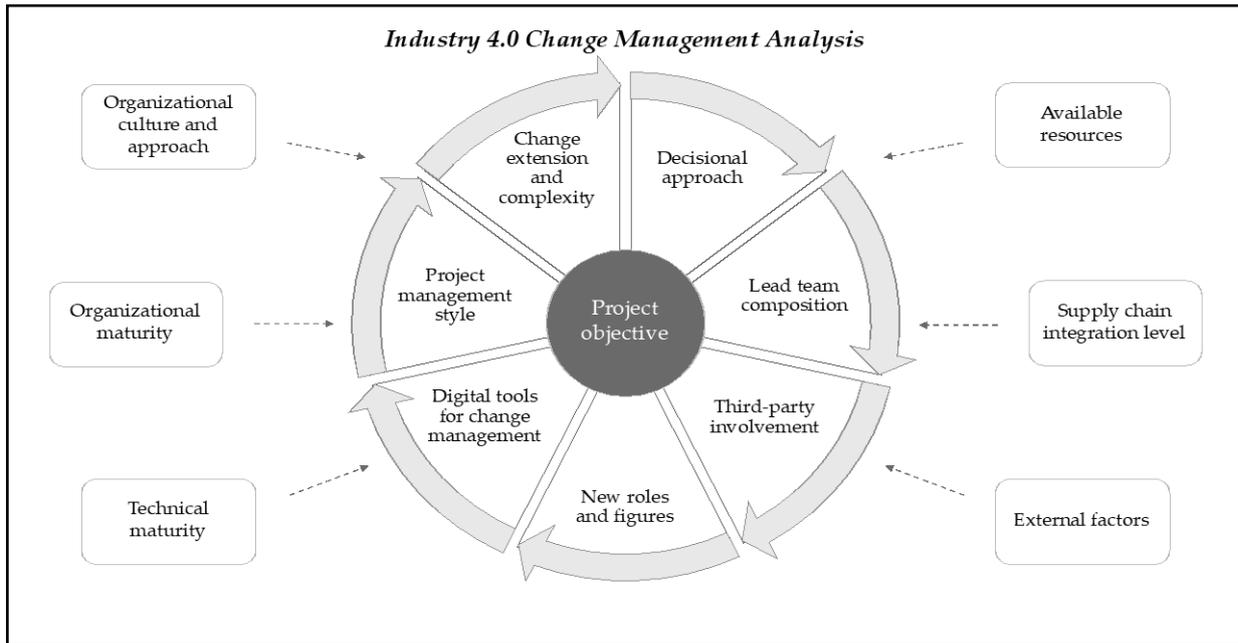


Fig. 1. Analysis framework

Defined the gaps, the research questions that this dissertation aims to answer are the following:

- RQ1: "How is the change management team composed when designing and implementing Industry 4.0 innovation inside an organization?"
- SQ1.1: "Which is the role of the HR function within the Industry 4.0 project?"
- RQ2: "How are resistances managed during the Industry 4.0 change management process?"
- RQ3: "Which are the contextual and environmental factors that affect the readiness of a firm towards the successful adoption of Industry 4.0 innovation?"

In order to answer the research questions in a reliable and coherent way, an analysis framework (Figure 1) has been developed, in which some key variables, distinguished in contextual and characterizing variables, enable the analysis of real-world case studies.

Methodology

The existing literature does not provide yet a structured scientific expertise on how companies deal with changes within Industry 4.0 contexts. Moreover, the topic is worth for a further investigation and requires further analysis. For these reasons, the chosen approach was an exploratory one to carry out the research and case study methodology seemed to be the most suitable.

The following were the criteria to collect the sufficient number of case studies: firms were implementing or had already implemented Industry 4.0 projects at the time of the research (April 2019 – November 2019); the location of the company was in the north of Italy, in order to guarantee a comparable national culture background; no restrictions over the company sector or the size for a greater possible generalization of the findings.

In the end, the analysis sample has been of five companies, whose summarized characteristics are in the Table 3 below:

Table 3 Case studies – Companies overview

| | Pharma Firm | Automotive Firm | Elevator Firm | Utility Firm | Electronic Firm |
|----------------------|---|--|---|---|---|
| Industrial sector | Chemical - pharmaceutical | Automotive | Metal-working | Utilities | Household appliances |
| Core business | Human and veterinary pharmaceuticals | Production of braking systems for motor vehicles | Production, maintenance and delivery of people flow solutions | Natural gas transport, dispatching, regasification, storage | Production of raw components for household appliances |
| Turnover | 39,59 billion € | 78,5 billion € | 8,94 billion € | 2,6 billion € | 43 million € |
| Size | 99.000 employees | 410.000 employees | 55.000 employees | 3.000 employees | 240 employees |
| Industry 4.0 project | Big data and analytics for predictive analysis; | Big data and real time analytics; Application of Machine | Automation production line; Real time data | IoT sensors to optimize the monitoring and | IoT sensors; Big data analytics; |

| | | | | | |
|--|--|--|---|--|---|
| | Integra- tion with MES and ERP; IoT sensors; Aug- mented Reality; Tablet for monitor- ing; | Learning techniques to predict and report critical sit- uations; IoT sen- sors; | monitor- ing; In- troduc- tion of a global unified MES to be inte- grated with the ERP; | maine- nance of infra- struc- tures; Big data and ana- lytics; Tablets with aug- mented reality applica- tions; | Weara- bles and smartph one ap- plica- tion within the plant; Integra- tion with MES and ERP |
|--|--|--|---|--|---|

In addition to the five firms reported in the Table 3, two additional companies have been indirectly analyzed by exploiting the insights shared by a consulting company, interviewed to add to the analysis a different point of view.

In order to collect information and empirical data about the reported companies, the choice was a multiple case study methodology. A structured questionnaire containing guidelines to conduct the interviews followed to have consistency among case studies. After interviews, all the audio records have been transcribed in order to analyze with an academic lens (rationalizing the contents and applying the analysis framework) what interviewees have said about the Industry 4.0 change undertaken by companies. Regarding criteria the ideal targets for interviews, the decision was to interview professionals of those companies who had been part of the smart manufacturing projects. In particular, interviewed employees covered roles not only belonging to the manufacturing area (e.g. production manager, industrial engineering manager, etc.), but also to other company functions (e.g. HR manager, Information Technology (“IT”) manager, project manager): the purpose was to catch the perspective of both people perceiving the main effects in the daily manufacturing operations and people more concerned by the organizational repercussions. In the end, the total amount of words in the transcriptions has been higher than 89.000, coming from more than sixteen hours of records.

5. Results

By addressing all the variables of the analysis framework, each case study has been analyzed, so that different and similar ways of managing the change among firms can be highlighted.

5.1 Pharmaceutical Firm

This company’s project, aimed at increasing the productivity of people and the efficiency of the production plan, has been focused on the implementation of technologies like augmented reality, real-time data analysis and electronic dashboards.

Briefly analyzing the environment surrounding this company with the framework of analysis, it is possible to observe a highly maturity both Organizational and Technical since they were conducting upskilling courses after having identified some gaps. In addition, a quite open decision-making context was already in place considering some bottom up processes to deliver continuous improvement. Then, it was possible to grasp that resources were not missing (neither financial or human).

The project followed the structure outlined in the Figure 2 below:

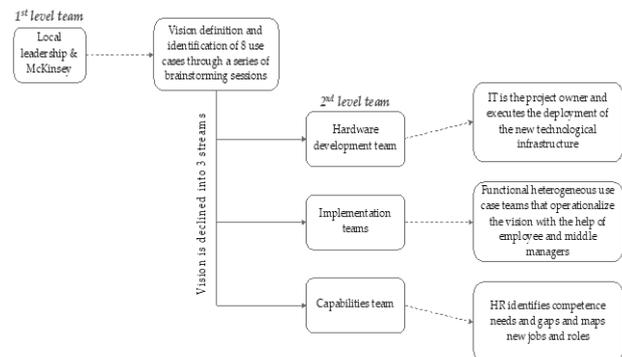


Fig. 2. Pharmaceutical firm change project structure

Considering the change management style, some key points must be highlighted: the decisional approach was bi-directional (top-down for the vision and bottom up for use cases identification) and inclusive of several functions and hierarchical levels; external actors has been included in the process as well as new hired workforce; project followed an iterative process to deliver value while keeping low the complexity level.

Looking at the project flow, at a higher level, top management (a heterogeneous lead team) engaged a consultancy company to co-design the vision and change roadmap to bring innovation at the lower level. This engagement came from a perception felt from the Chief Executive Officer of this company who then transferred it throughout all the hierarchical levels.

At the lower level, three work streams worked in parallel with a distributed ownership. In particular, one the Tech innovation in terms of HW deployment. In parallel, exploiting the quick wins of these work streams, some use cases flourished all around the shop floor that has been then scaled up and brought in the daily operations bringing higher efficiency (e.g.digitalization of some processes part through Tablets to monitor quality).

5.2 Automotive Firm

This company's project, aimed at both increasing the productivity of the assembly lines and enhancing the effectiveness of firm's products, has been focused on the

main enabler was put in the work conducted by HR function in the capabilities streams as well as by IT that drove implementation of technologies like IoT sensors for machine monitoring, predictive maintenance and big data analytics within the production plants.

Briefly analyzing the context, high technical maturity and organizational maturity could be noticed since HR were already used to conduct surveys and find how to empower workforce. This company was extremely integrated with its suppliers following a Just in Time methodology combined with a Lean number of hierarchical levels in a matrix organizational structure could be found.

The project followed the structure outlined in the Figure 3 below:

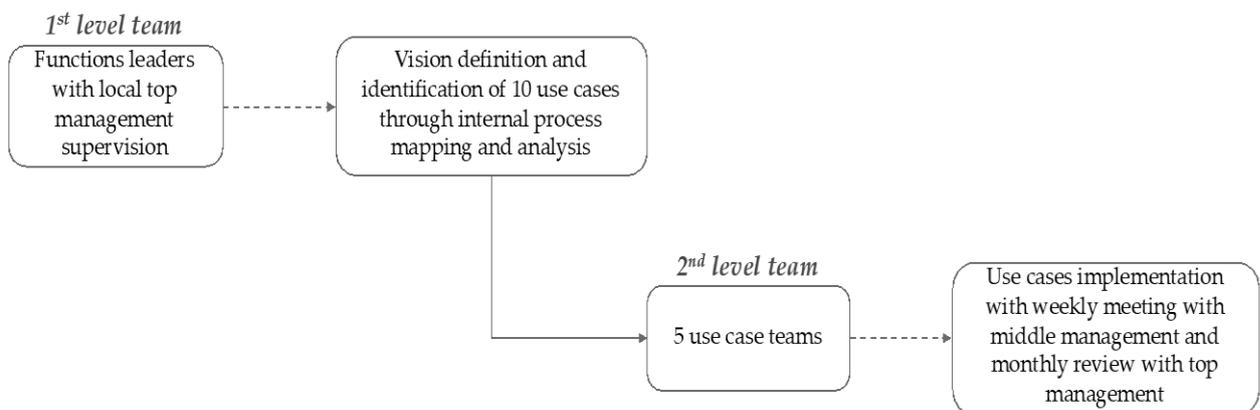


Fig. 3. Automotive firm change project structure

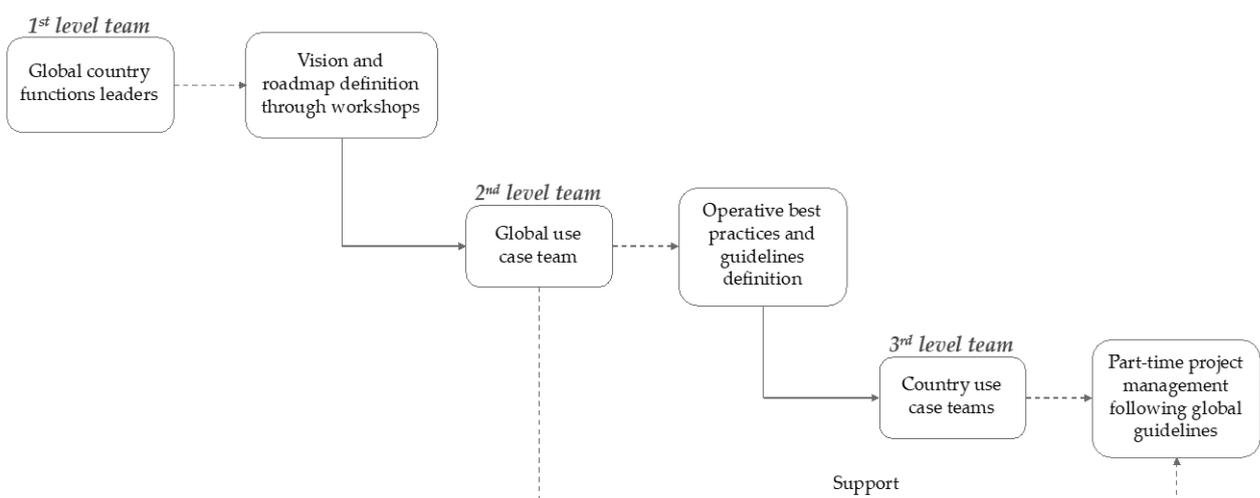


Fig. 4. Elevator firm change project structure

Manufacturing cultural approach. Finally, a low Analyzing the change management style, this is what was observed: the decisional approach had been inclusive since the beginning with all the management involved as well as some blue collars representatives. New roles have been created to face the need of new competences. The project was faced in a design thinking way with the implementation of co-creation workshops and agile sprints only over the identified areas.

After the country manager's perception of an innovation need, top management board, involving leaders of all functions, firstly focused on creating a shared vision. Then, they conducted some workshops whose output was the identification of use cases to deploy along their processes.

As a second step, five multi-disciplinary inter-functional use case teams (including also HR, IT, Operations) focused over one specific innovation area each, implementing new digital processes and tools while updating middle and top management on a regular basis. During those sprints, new best practices and new roles came into daily routines and a continuous innovation mindset spread all over the company, increasing productivity.

5.3 Elevator Firm

With the objective of increasing its production lines productivity, the firm has started the implementation of automated machines in its plants, connected and integrated with the information systems

to perform real-time data analysis.

Elevator Firm context was characterized by a strong pressure of labor unions as well as by a risk adverse culture. Some people formed a sort of expertise center regarding IT technologies. Some constraints about financials were present.

In particular, the project followed the structure outlined in the Figure 4 below:

About Change Management, the decisions had been flowed top-down (from the group Headquarters to the single country plants). All the process has been internal with the exploitation of distributed Center of Expertise around the globe. The project management followed a classical waterfall approach and was assigned to an identified person in each country. Any new role has been introduced since they tried to adopt I4.0 innovation to the actual landscape.

This Industry 4.0 project was born at a central level within the global board of directors. All the global functions and country leaders have been involved to create a vision and a roadmap. After that, at an intermediate level, each global use case team set guidelines and developed best practices involving technical and managerial people from operations, maintenance and data analytics.

The last step to bring innovation in the shop floors was at a local level where a country use case team, with a part-time support of the corresponding global one, managed the rollout of single innovative use case along the plant floor (e.g. IoT production monitoring). In this context, HR function was involved only after the implementation to manage labor unions. The outcome of higher efficiency in the Italian plant was reached with huge efforts and in delay in comparison to the project plan (i.e. the worst case of change and project management).

5.4 Utility Firm

In order to improve operational flexibility and enhance its asset management system, the firm undertook a project focused on the implementation of technologies like augmented reality, IoT sensors and big data analytics to support its operators in day-by-day operations.

The environment surrounding the Utility Firm was characterized by a friendly working context whit HR creating commitment into workers to achieve their goals together and improving some aspects to build a mature organization. In addition, IT Technologies was under renewal, at the time of the research, to improve technological maturity. Massive financial investments were present in the budget of the company.

In particular, the project followed the structure outlined in the Figure 5 below:

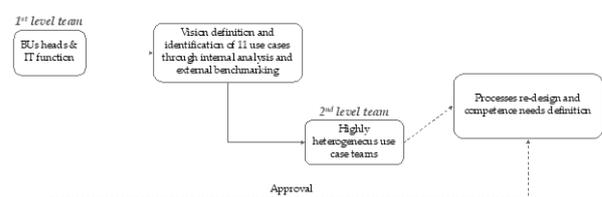


Fig. 5. Utility firm change project structure

Taking a deeper view over the change management style, this is what was observed: the decisional approach involved many different stakeholders since the beginning; new job titles have been introduced (either hiring

from the external labor market or by moving internal resources); iteration during the roll-out phase of the project were the standard approach with some co-creation moments facilitated by external actors.

This Utility firm top management perceived an innovation need driven by the higher competitive market. All Business Units general managers and IT leadership team collaborated to design a vision and identify eleven use cases coming from an internal operations analysis and an external benchmarking.

At a lower level, highly heterogeneous teams (both in terms of functions and in terms of hierarchy and with the facilitation of consultants) focused on one use case each, managed the process re-design and collaborated strictly with HR function to define the new competences needed (e.g. remote collaboration for infrastructure maintenance). The innovation was then widely adopted throughout daily operations increasing efficiency with low resistances.

5.5 Electronic Firm

This firm's project, aimed at radically changing the business of the firm by both increasing productivity and exploiting new market opportunities, was focused on the implementation of technologies like IoT sensors for machine monitoring, smart wearables and big data analytics within the production plants.

Electronic Firm moved inside an environment typical of a family firm: lots of emphasis was over the workforce welfare while trying to stay updated over the last technological trend also creating a new function (showing high level of organizational maturity). This is the only Small-Medium Enterprise and it was the one with the highest lack of Human Resources since it was not easy to attract talents, even if financials were not a problem, and actual resources were saturated. A strong integration with their suppliers and customers was observable. Finally, a continuous improvement mindset characterized the top management choices and company culture.

In particular, the project followed the structure outlined in the Figure 6 below:

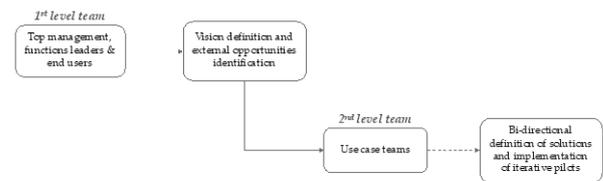


Fig. 6. Electronic firm change project structure

Taking under consideration how change was managed, this is what was observed: a real agile project management approach was adopted meaning that complexity had been kept low by rolling out a small portion of the project at a time to validate assumptions. Then, a complete new business unit was formed to coordinate this change while involving all the impacted functions in the decision-making. Finally, customers have been involved to design the flow and to receive their feedbacks.

Top management was looking for new sources of competitiveness and decided to launch some workshops and call for ideas open to all functions and hierarchical levels, despite it reduced productivity for a limited period. The output from this process helped top management to define a vision and identify most relevant opportunity.

At the lower level, different use cases were addressed one at a time (starting from predictive maintenance to industrial machine big data analysis) following an iterative and bi-directional process: the innovation team involved directly internal end-user to co-design and adopted a human-centric agile approach. What happened is that the innovation came strongly into every process not only enhancing efficiency but also opening new business opportunities: a new unit of business opened just after the change even if they are struggling to hire new employees with job titles belonging to the Information and Communication Technology environment. This new Business Unit creates SW products addressing both internal manufacturing plant and other firms' factories and supply chains (which were already integrated in a lean way) going on global scale.

5.6 Consulting company's case studies

The last two case studies are the outcome of information gathered by interviewing a consulting firm involved in the 4.0 projects' implementation. Since both reported projects were still under development, it was possible to analyze the framework variables only partially.

Looking at the project objectives, both firms aimed, in two different ways, at the same result, to directly connect their customers with their production system. Therefore, the objective was to both increase flexibility and to enhance effectiveness on the market, requiring a partial re-design of the production and of the information systems.

In these cases, innovation came into with the involvement of consultancy firms giving to the top management a broader perspective to show trends and related benefits. Of course, a driver of this request was the perception of firms' management of a technological gap in comparison to the competitive landscape.

Besides that, other common aspects were decision-making moments with involvement of different hierarchical levels together with a multitude of functions. Indeed, the change they are addressing involved many functions, not only the productive ones.

In the end, looking at the environmental aspects, a relevant supply chain integration level was sought and a culture prone to change was formed by the HR.

5.7 Expert's perspective

During the discussion with the consulting firm's expert, several focal points was touched and explained. Under his point of view, it is possible to differentiate the objective of an Industry 4.0 project into two categories that can have different effects on the outcome: Industry 4.0 can enable just efficiency or also enhance customization and effectiveness that can really disrupt the market

Then he has highlighted the need of a digital-oriented culture, besides an organizational and technical competences required during the change. He has also pointed out the need to have an agile project management style and a change lead team that should be heterogenous both horizontally and vertically, involving in some way all hierarchies during the process. In this context, HR could be a great resource, especially for issues related to corporate culture.

Looking at the exploitation of supply chain synergies, he has reported that companies should always think about the impacts on the customers and should look at the market changes to follow them, employing Industry 4.0 as a way to create higher level of integration.

In the end, he expressed his mind about labor unions: since they can be a source of problem or a resource, they need to be managed carefully.

6. Discussion

After applying the framework of analysis to describe and assess individually the case studies of each company, a cross-case analysis is provided with the objective to point out patterns, common features and clusters that emerge when all change projects are examined systemically.

From the real-world evidences, some observations come from similarities and differences analysis among the case studies. Some insights were useful to answer the research questions, some others only to be reported in the cross-case analysis. In particular, this analysis allowed studying case studies analogies, worst and best cases differences and cross-fertilization features.

Starting from certain observations, that do not address a specific research question, it is possible to report some insights related to differences and similarities between SMEs and large companies. The Electronic Firm is a positive example of Industry 4.0 implementation and it is the only SME in the sample. In fact, it is possible to point out that few differences have emerged in comparison to the other positive observed case studies. In particular, the impact of the reduced size can be observed only in three framework variables: 1) it has created difficulties in attracting and acquiring talents; 2) it has implied a higher saturation of resources, lowering the overall availability; 3) it has created a greater flexibility that allows the exploitation of "pure" agile practices in the project execution style and a higher level of heterogeneity in project teams in terms of functions and of hierarchical layers involved, thus allowing a pure bottom-up decisional approach (the only in the firm sample).

Another important observation not addressing any research questions is about the potential or actual level of integration along the supply chain. In fact, the exploitation of synergies along the supply chain with specific actors affects the project final objective: indeed, the only firms leveraging an integrated supply chain have pursued not only efficiency objectives, but also competitiveness and effectiveness on the market.

6.1 First Research Question

Looking at the first research question, case studies have reported some insights to fill the gaps on the composition of project governance (Toytari, et al., 2018). First, the necessity to move away from the traditional approach emerges, since one lead team and change agents are no longer suitable for this type of change (Bartezzaghi, 2010). Indeed, Industry 4.0 project governance needs to be developed on more levels: a higher

level in which a vision team has to define the project strategy, and a lower level in which multiple teams deal with the development of single use cases. All these teams must involve people from different corporate functions, from industrial to commercial ones, guaranteeing heterogeneity of competences. Moreover, if involved properly in project and lead teams, actors outside the company (e.g. consultants, system integrators, etc.) can have an important role in guaranteeing innovativeness.

Looking specifically at the role of the HR function, some cues emerge. What is reported from the case studies, something not considered in the literature, is that HR must participate in the governance of the project and not simply support seldom the lead team, meaning that it must be involved at least in the use case teams. This because the HR function is not only responsible for the training of employees (as said in literature) (Secchi & Rossi, 2018), but it must take charge of the innovation-oriented cultural change that the introduction of the Industry 4.0 paradigm entails, too. Moreover, this position is reinforced since HR covers a fundamental role in engaging the trade union, one of the external actors to be actively involved in the change process, as well as in setting the right level of organizational maturity to be ready for this disruption.

6.2 Second Research Question

Investigating whether traditional change management practices for reducing resistance remain valid even in Industry 4.0 contexts or whether new ones need to be developed (Sony & Naik, 2018), a first cue is that the use of digital tools is not so widespread (i.e. no real world observations), contrarily to what is reported by the literature (Niess & Duhamel, 2018).

A second observation can be made on the top management approach. In particular, the active role of the top management is one common characteristic of every successful case, meaning that it should be involved during both the launch and the execution of the project, at least for revisions at a regular basis that could facilitate support the defined decisional approach. In this way, a holistic view of the company could be beneficial to identify how innovation could serve the whole company. In addition, doing so, resistances from both the top and middle management are reduced, and indirectly, commitment is more effectively spread among informal leaders too.

Communication maintains its fundamental role as seen in traditional change management (Bartezzaghi, 2010), but with a greater focus on reverse reporting (i.e.

from bottom to top) that is becoming more and more important, reducing the risk of not-acceptancy of the new technology and increasing the commitment around the project even in the bottom levels of the pyramid. In this way, it is also possible to exploit indirectly the influential network of employees in order to lower the resistances around them and spreading innovative ways of working more quickly.

Looking at the relationship between barriers lowering and time constraints or other complexity characteristics of the context, no evidence of impact can be found, meaning that managerial style of change does not depend upon the project time objective, extension or environmental complexity. It is of little importance if there is a short-term perspective or a long-term one: resistances and, in general, the project, must be managed always in the same way (Jing & Van de Ven, 2018) following the best practices.

Finally, the last important aspect useful to lower barriers is the creation of new professional figures (e.g. data scientists), finalized to make the change fixed (Hecklau et al., 2016). New roles and figures not only create the right conditions for a successful change by adding new necessary competences if the technical maturity is not so high, but also play a fundamental role as change stimulators, accompanying quick wins by bringing their knowledge and expertise related to innovation beneficial for the whole change team.

6.3 Third Research Question

The last research question investigates the absence or presence of enablers that a company must have to implement more easily an I4.0 project. Firstly, some considerations can be made on the enabling competences. As reported in the answer to the first research question, having HR expertise is necessary to drive the cultural change. Similarly, IT skills are required, even if firms can access them through third-parties involvement. What turns out to be important is that the IT function evolves with the aim of becoming a business support function, able to guide the choices on the technologies that are at the basis of the information generation, processing, storing and sharing. Contrarily to what is reported by literature (Hecklau, et al., 2016), Industry 4.0 related skills are not necessary at the beginning of the change process, since they can be developed along the way, meaning that it is essential to develop an on-going accompanying plan to build them during the course undertaken by the company (Liboni et al., 2019).

Besides skills, organizational maturity and culture are other two fundamental enabling factors. On one hand,

the firm needs to be able to map, analyze and manage internal process and competences to find gaps and plan improvement measures, and on the other hand, corporate culture needs to be prone to a continuous improvement mindset together with an inclination to internal and external collaboration, fundamental to commit all hierarchical levels and external actors. Moreover, a particular mention must be done to the importance of having a distributed leadership within the company, not dictated by the hierarchy, to be exploited during change implementation for commitment creation, innovation spread and enhancement of the decisional process (Hermann et al., 2016).

Finally, no evidence has been found on the impact of the sector type over the project results, meaning that it cannot be considered as a fundamental enabling factor (Sony & Naik, 2018).

7. Conclusions

Looking at the answers to the research questions, it is possible to resume some managerial implications that could be exploited by practitioners when dealing with this type of change:

- Managers should prepare the change by shaping the culture in the suggested way leveraging on traditional practices and tools;
- Management should build strategic partnerships in order to be ready to collaborate with third parties to have different perspectives and all the needed competences at the table to grasp innovative trends;
- A cultural enabler trait that managers should develop is the internal collaboration by creating ad hoc collaborative moments and acting as role models in this sense sharing best innovative practices;
- HR function should be directly involved within the different project teams, so that cultural changes, plans to fill the skills gaps in an innovative context and relationships with trade union can be addressed properly;
- Management should focus on building organizational competences ex-ante while the technical ones can be developed during the implementation of the change, following precise training plans;
- Managers should set up the change governance in a heterogeneous way (both functional and hierarchical) and over two levels: in the higher one, a vision team which design the innovation roadmap, while in the lower one, different use case teams which would roll-out innovative projects;

- Top management should be involved from the formation of the vision and it should be updated constantly throughout revision meetings in order to be aligned, to share thoughts and to show commitment;
- New professional figures or roles should be introduced by insourcing them from external market or by developing competences internally;
- Managers should collect feedbacks and enable co-creation moments with informal leaders.

The research has been conducted in a structured way, but some limitations need to be acknowledged and some directions for future research should be indicated.

Firstly, a limitation can be identified looking at the geographical constraints applied to the company selection that could have influenced some variables due to the same national culture. This limitation could be overtaken by applying the same research protocol and framework to a new set of companies in other areas of Italy, Europe or the World.

Secondly, the application of the framework only to already implemented cases presents a limit. A possible option to obviate this limit could be to apply the framework during the implementation of an Industry 4.0 project instead of analyzing finished projects, so that different phases' peculiarities can be deepened.

Then, the number of case studies is not statistically relevant, even if it is possible to observe a convergence of the results. It would be important to test the findings among a new and larger set of case study in the same conditions in order to find some significant statistical inferences.

Finally, there are other areas to conduct further research. For instance, it would be important to apply this framework to a significant number of SMEs to understand if the single-case observations reported in this dissertation are confirmed or not.

In general, the adoption of the Industry 4.0 paradigm and the digitalization of manufacturing processes represent a great opportunity for the world's production systems, but it is still a niche topic among practitioners and academicians. Going some steps ahead with the study of this new mega-trend is fundamental in order to allow an always greater audience to grasp the benefits coming from it. Since the fourth industrial revolution is not only the introduction of new technologies and software, but it is firstly a redefinition of processes, balances and dynamics, it cannot exist without a well-structured change management strategy able to involve the entire company. Therefore, without a corporate organizational

change and a technological project execution, Industry 4.0 remains just a chimera.

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Reimagining Future of Future by redesigning Talent Strategy in the Age of Distraction and Disruption

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Abstract

The coronavirus 2019 (COVID-19) pandemic promoted the development of Industry 4.0 leading to the fifth industrial revolution (Industry 5.0). It brought in new ways of working and the role of the office in the future. It redesigned the workplace to support organizational priorities and resize the footprint creatively. Digitalization and globalization have sparked radical shifts in how employees live and work. In an age of digital disruption, companies and HR leaders are forced to revise organizational on how they organize, recruit, develop, manage and engage the 21st-century workforce. The big questions are: how can HR help business leaders reconstruct the workforce of the future? What effort has the company take to change future work and their workforce today so that it looks different 15 years later? Organizational agility, careers and learning disruption, talent disruption, rethinking performance management and people analytics in addition to creating the right structure, analysis, and standardized people metrics are the key to success and critical drivers to design talent strategy. This study aims to identify the magic ingredient (or strategies) behind managing an organization's talent in creating business success. We further examined and mathematically modelled these strategies in attracting and retaining high-quality employees, developing their skills, and continuously motivating them to improve their performance in the age of distraction and disruption. 354 employees from IT companies participated in the survey. The findings of the study show, as expected, that a compelling employer brand is the most effective talent management strategy of all when it combines three key drivers: organizational culture, organization goodwill and competition for talent. Gender was statistically, significantly and positively associated with the imperatives to reset the future of work agenda.

Keywords: Diversity, Local leader, Mental Health Support, Remote Work, Talent strategy, Transparency

2. Introduction

The 5th industrial revolution (5IR or Industry 5.0) places greater importance on human intelligence than ever before. The shift from the fourth industrial revolution (4IR) to the fifth industrial revolution (5IR) carefully integrates man and technology. It changed routines in almost every field particularly information technology and made it obligatory to speak about alternative researches and innovations in the future workplace. It is hard to imagine a more radical shake-up of the modern workplace. For a longtime, workplace flexibility has been a sought-after perk which many organizations were unwilling to offer, and instead locked in workers to long

commutes, rigid work hours and tension between a competing career and family pressures. But in this day and age the pandemic offers a rare chance to rethink the way employees work. Top management requires that they nurture their company's culture to ensure that people stay focused on the most imperative initiatives, while contending with unprecedented challenges and continuously changing conditions presented by the pandemic. They need enduring care and cultivation of employees if this is to thrive. Employers must remember "Do not step on people's toes just to get to where you want." Employees invest their time, and employers need to unrestrict necessary employees to make this happen, and

they should ensure that the right people lead it as well. At this juncture the basic fundamental questions are how they fit into the new culture and the future workplace. As employees spend more hours of work to expedite the process of recovery, are employers reciprocating this sense of empathy and need toward employees? How are employers working to empower employees and adjusting their system in a hybrid workplace? Ensuring that constructive changes endure beyond the pandemic requires new methodologies, culture, digital transformation and evaluating change initiatives. Another imperative question is how to tackle remote working efficiently with the disruption in normal daily life? Digital transformation may help streamline communication, facilitate learning, foster connection and allow people to thrive in the new future of work. It has had a dramatic impact on the employee experience. Organizations serious about high-performance must rethink the way they measure performance in a post-pandemic world. In this case how should organizations calibrate their productivity and performance yardsticks? As employers look toward the future, employee wellbeing will need to feature at the top of their list as it will advocate business transformation successfully even in times of crisis and uncertainty. Hence employers looked to power their practice and improve ROI with redesigning Talent Strategy which could return the organization to its pre-pandemic state immediately. This research work also aims to find answers to the above said valid questions and explore the best and reliable talent strategy techniques to make quick, evidence-based decisions to build on existing capabilities and thus gain a competitive advantage in the future workplace. This research study makes an attempt in that direction and seeks to fill this research gap.

3. Review of past literature

Prepare There are studies that instead say that the expected impact of virtual reality was quite different to what was expected. Employees live in a distracted, secular age. They can work from where they live and their employer can monitor their performance and correspond with them. It may be both good and bad. But companies must fix the talent mismatch by using potential strategies.

Chopra & Bhilare, (2020) recommended at the end of their research that millennials are seeking a strong mentor work environment and need a road map to help them grow. Ware, 2018 emphasized the watchwords on the future of work that ensure ease in innovation, collaboration, integration and agility. Organizations that adopt management values and practices will thrive while

the context of work will itself change. The study of Bedwell & Florida (2014) revealed that as collaboration underpins all business operations, executives consistently grade interpersonal skills as a key competency for an effective workforce. Davis & Blass, 2018 found evidence of universal social protection for the future of work and new perspectives related to the existence of new forms of employment, such as work on digital platforms, and responding to specific situations and needs of such workers, to realize the human right to social security for all. Karenza Moore et al (2008) investigated stories of the future in relation to women in the information and communications technology (ICT) sector and understood the significance of gender, work, time and technology.

Nguyen, et al studied the twofold challenges of competing in a global market and speedy technological advancements that redesign the workplace into an innovative work environment known as the high-performance workplace. They concluded that high-performance workplace results from constantly balancing investment in people, process, physical environment and technology, to measurably enhance the ability of workers to learn, discover, innovate, team up and lead, and thereby achieve efficiency and financial benefit. Overtoom, (2000) reported that Formal education and training systems play a significant role in creating opportunities for young employees to acquire the essential core skills needed in a workforce. James Francis and Carolien Scheers (2013) explored that traineeships and internships help young Europeans to improve their skills and adjust to the new workplace. Further Hisa & Mohiddin, (2020) described that current trends are based on the features of high performance workplaces. By observing the research work of Kniffin et al., 2020, smarter and safer ways to work together continue to reap benefits from global cooperation. Durai & King (2018) suggested positive action to achieve the organizational goal and interests will master an employee's role, and tap into an unsurpassed peer network. Gary L. Freed, MD, et al (2015) stated that the proper time allocation for specific duties in their current position was consistent with their goals, without gender inequality.

Thus, to put it in a nutshell, evaluation of the above stated national and international studies revealed that proficient insights and strategies to address talent crises can resolve the most demanding challenges. But It was found no unique talent matrices to develop workers as be operative and as efficient as possible in supporting business goals and providing value. The focus of this study is to explain the key elements of successful talent

strategy in the age of distraction and disruption from the collective opinion of employees.

3. Research objectives

Broadly, the idea for undertaking this research is to investigate talent management strategies that companies need to prepare for the future of work

4. Hypotheses of the study

On the basis of the defined objectives, the subsequent hypotheses have been developed:

- a. Future (a). The future of the Future Workplace mainly depends on talent management strategies such as agile management, outsourcing (both to humans and machines), prioritizing employee experience, harnessing the power of virtual reality (Jiayan Zhao et al.2019), work being filled with purpose, a new breed of leadership, compelling employer brand and being digital right from the corecore
- b. There is significant difference between strategies inducing talent management to build an effective future workforce and gender.

5. Research methodology

Descriptive research design was a take on for the study. Convenience sampling technique was deployed. Respondents were more comfortable in responding to the survey electronically rather than physically during this pandemic. The study was carried out with the use of a specially designed questionnaire. The survey instrument used a 5-point Likert scale to obtain feedback. The research questionnaire was sent to IT professionals in the southern state of India. All were from companies with 300 or more employees; more than 48 percent of respondents were from organizations of 500 or more employees. The survey was undertaken in the southern states of India, representing companies with headquarters in Karnataka (52 percent), Tamilnadu (20 percent), Andhra Pradesh (15 percent), Telangana (9 percent), and Kerala (4 percent).The respondents were from a variety of information technology industries: 15 percent worked in Help Desk IT Services ;16 percent were from Network Security; 11 percent were in Data Storage and Management; 17 percent were from Data Storage And Management; 11 percent were in Data Backup Services and 17 percent were in Web Designing Services. Email

Marketing Services made up the remaining 13 percent. The respondents were largely senior-level executives: 24 percent were executive management or board members; 23 percent were senior management; 34 percent middle management; and the remaining 19 percent other grades. The largest percentage, 32 percent, manages a group of people within a department, while 29 percent have people management responsibility for the whole department. 26 percent have people management responsibility for the whole business unit, and 23 percent extend the responsibility throughout the corporate. A total of 354 respondents completed the survey. To analyze the responses from the respondents, statistical software SPSS was employed. In this study, the responses and information brought were tested using statistical techniques such as reliability test, descriptive.

6. Analysis and results

There are five main stages in the analysis and interpretation of qualitative information collected through a structured questionnaire from IT professionals from Southern state of India to assess the future of future workplace.

- (i). Cronbach's alpha was calculated to test reliability of the research instrument.
- (ii). Descriptive statistics was used to explore dominant drivers of various talent management strategies and check normality.
- (iii). Principal Component Analysis with Varimax Rotation and Kaiser Normalization was resorted to assess the underlying structures for the 16 drivers of talent management strategies.
- (iv). Multiple regression analysis was used to assess the strength of the relationship between the future of the Future Workplace (the dependent variable) and eight talent management dimensions (predictor)

6.1 Reliability check of research instrument

Reliability of the measurement was done through the use of Cronbach's alpha coefficient



Table 1 Reliability Statistics

| Cronbach's Alpha α | N of Items |
|---------------------------|------------|
| 0.627 | 16 |

A generally accepted rule is that α of 0.6-0.7. Cronbach's Alpha value 0.627 indicates an acceptable level of reliability, and research instruments were of a very good level.

6.2 Exploring key drivers of talent management strategies that that will impact the future of work

The study was conducted to investigate the key drivers of talent management strategies that will accelerate future workplace. Table 2 shows 16 drivers which were derived through an extensive literature survey. 5-point Likert scales used in the questionnaire permitted the respondents to decide their level of agreement or disagreement. Therefore, it goes from complete agreement to a complete disagreement, assuming that attitudes can be measured. Table 1 gives the descriptive statistics namely, the mean score and standard deviation of the 16 drivers enhancing the future of the future workplace. Of the 16 drivers Organization Goodwill Collaborative training (\bar{x} =4.18), Organizational Culture (\bar{x} = 4.11), Clear purpose with the best talent (\bar{x} =4.05) and Freelance projects (\bar{x} =4.02) were the top four drivers shaping talent management strategies which intensely unify the future of the future workplace with an above 4 mean score. However, the remaining factors with mean scores of above 3 were also supportive of the future workplace. It indicated that the mean score variable was at a good level. Fig 1 also advocated the same. Values of standard deviation also were closer to the true value than those that fell in the area greater than $\pm 2SD$. Data was considered normal as skewness of all factors was between -2 to +2 and

Table 2. Descriptive statistics of Key determinants that accelerate future of future workplace

| Key Drivers | Items | Sum | Mean | Rank | Std. Deviation | Skewness | Kurtosis |
|-----------------------|-----------------------|------|------|------|----------------|----------|----------|
| Organization Goodwill | Organization Goodwill | 1257 | 4.19 | 1 | 0.70 | -0.81 | 1.11 |
| Freelance projects | Freelance projects | 1206 | 4.02 | 5 | 0.81 | -0.37 | -0.61 |

| | | | | | | | |
|---------------------------------------|---------------------------------------|------|------|----|------|-------|-------|
| Organizational Culture | Organizational Culture | 1233 | 4.11 | 3 | 0.77 | -0.58 | -0.06 |
| Compete/competition for talent | Compete for talent | 1137 | 3.79 | 8 | 0.95 | -0.55 | -0.26 |
| Reinvent skillsets | Reinvent skillsets | 1095 | 3.65 | 12 | 1.05 | -0.40 | -0.85 |
| Frequent peer-to-peer feedback | Frequent peer-to-peer feedback | 993 | 3.31 | 14 | 1.07 | -0.30 | -0.81 |
| Digital work-spaces | Digital work-spaces | 1125 | 3.75 | 10 | 1.03 | -0.78 | 0.09 |
| Digital Culture | Digital Culture | 1131 | 3.77 | 9 | 1.09 | -0.81 | -0.01 |
| Spot poor leaders | Spot poor leaders | 966 | 3.22 | 15 | 1.14 | -0.15 | -0.79 |
| Coherent vision | Coherent vision | 1047 | 3.49 | 13 | 1.06 | -0.58 | -0.10 |
| Right environment | Right environment | 903 | 3.01 | 16 | 1.14 | 0.02 | -1.00 |
| Remote working | Remote working | 1176 | 3.92 | 7 | 0.91 | -0.95 | 0.98 |
| Collaborative training | Collaborative training | 1254 | 4.18 | 2 | 0.85 | -0.84 | 0.03 |
| Clear purpose with best talent | Clear purpose with best talent | 1215 | 4.05 | 4 | 0.81 | -0.44 | -0.49 |
| Sense of purpose with personal values | Sense of purpose with personal values | 1197 | 3.99 | 6 | 0.76 | -0.68 | 0.60 |
| Employee experience | Employee experience | 1119 | 3.73 | 11 | 0.84 | -1.01 | 1.88 |

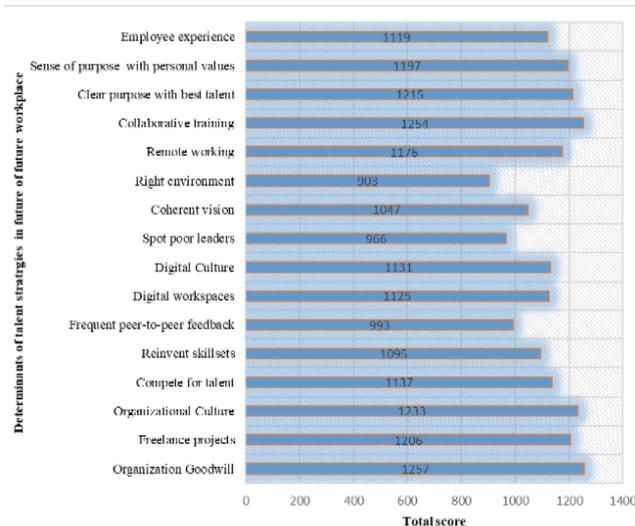


Fig 1. Key drivers of talent management dimensions that influence the future of the future workplace

6.3 Exploring the key talent determinants/dimensions of the future of the future workplace

6.3.1 Principal Component Analysis with Varimax Rotation and Kaiser Normalization:

This article was intended to determine the important drivers for various talent management strategies. To being with, EFA (Exploratory Factor Analysis) was employed to accomplish the goal of exploring the key drivers for each talent management dimension leading to the future of work transformations. The results display the presence of eight dimensions that add up to form vibrant talent strategies for the future workplace. Before applying EFA on all items of the questionnaire, each construct (dimension) was explored using EFA.

Determinant value generated in the correlation matrix for this study data was 0.033 which was larger than the obligatory value of 0.00001. Hence, multicollinearity was not an issue for the study data. To ascertain the suitability of data for structure detection, KMO and Bartlett's test were used. The end results are shown in Table 3.

The sufficiency of KMO measurement sampling (to determine whether sample response was sufficient) should be close to 0.5 for satisfactory factor analysis. Kaiser

(1974) recommended a value of 0.5 (the value of KMO This is well supported by the KMO (Kaiser - Meyer - Olkin) value of 0.573, which indicated reducing several drivers to pure dimensions was appropriate. In another word, data had no serious problems of multicollinearity; hence, the drivers were appropriate for factor analysis. Further, Bartlett's test of sphericity significance value was 0.000, $p < .05$ (.000 < .05), revealing that correlations in the data set were appropriate for EFA.

Table 3. KMO and Bartlett's Test

| | | |
|--|-------------------------|----------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy: | | 0.573 |
| Bartlett's Test of Sphericity | Approximate. Chi-Square | 1003.138 |
| | Degrees of Freedom | 120 |
| | Significance | 0.000 |

SPSS output as seen in Table 4 lists the Eigenvalues and hence the variance explained by each dimension. There were eight talent management dimensions that had an Eigenvalue of greater than 1, as shown in Table 4. These eight dimensions contributed to 75.260 percent changes in the overall variance (future of the future work and workplace).

Table 4. Total Variance Explained

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|-----------|---------------------|------------------------|-----------------------|-------------------------------------|------------------------|-----------------------|-----------------------------------|------------------------|-----------------------|
| | Sum | Percentage of Variance | Cumulative Percentage | Total | Percentage of Variance | Cumulative Percentage | Total | Percentage of Variance | Cumulative Percentage |
| 1 | 2.623 | 16.395 | 16.395 | 2.623 | 16.395 | 16.395 | 1.835 | 11.466 | 11.466 |
| 2 | 1.987 | 12.421 | 28.817 | 1.987 | 12.421 | 28.817 | 1.741 | 10.882 | 22.349 |
| 3 | 1.839 | 11.495 | 40.312 | 1.839 | 11.495 | 40.312 | 1.732 | 10.823 | 33.172 |
| 4 | 1.590 | 9.937 | 50.249 | 1.590 | 9.937 | 50.249 | 1.702 | 10.635 | 43.806 |
| 5 | 1.347 | 8.421 | 58.670 | 1.347 | 8.421 | 58.670 | 1.610 | 10.065 | 53.871 |
| 6 | 1.019 | 6.366 | 65.036 | 1.019 | 6.366 | 65.036 | 1.156 | 7.227 | 61.098 |
| 7 | .875 | 5.469 | 70.505 | .875 | 5.469 | 70.505 | 1.136 | 7.098 | 68.196 |
| 8 | .761 | 4.755 | 75.260 | .761 | 4.755 | 75.260 | 1.130 | 7.065 | 75.260 |
| 9 | .713 | 4.458 | 79.718 | | | | | | |
| 10 | .676 | 4.227 | 83.945 | | | | | | |
| 11 | .669 | 4.183 | 88.128 | | | | | | |
| 12 | .492 | 3.078 | 91.206 | | | | | | |
| 13 | .424 | 2.649 | 93.855 | | | | | | |
| 14 | .358 | 2.237 | 96.092 | | | | | | |
| 15 | .343 | 2.143 | 98.236 | | | | | | |
| 16 | .282 | 1.764 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

Variables with high communalities -say more than 0.40 in Table 5 contribute much to measuring the underlying drivers. The rotated component matrix displays the association between the drivers and their dimensions after varimax rotation. It specifies “which drivers measure which dimensions?” and are labeled as below.

- (a). Dimension 1 consists of Digital Culture and Digital workspaces pertaining to Digital right from the core.
- (b). Dimension 2 consists of Competing for talent, organizational culture, and organization goodwill related to a compelling employer brand.
- (c). Dimension 3 consists of spotting poor leaders, Right environment, and coherent vision pertaining to a new breed of leadership
- (d). Dimension 4 consists of clear purpose with best talent and sense of purpose with personal values related to work filled with purpose
- (e). Dimension 5 consists of Collaborative training and Remote working that harnesses the power of virtual reality.
- (f). Dimension 6 consists of employee experience and reinventing skill sets that prioritize employee experience
- (g). Dimension 7 represents Freelance projects that desire outsourcing both to humans and machines.
- (h). Dimension 8 signifies Frequent peer-to-peer feedback that characterizes an Agile management

Table 5. Results of Communalities and Rotated Component Matrix

| Dimensions | Items | Communalities | Rotated Component Matrix | | | | | | | | | | |
|-----------------------------|------------------------|---------------|--------------------------|------|------|---|---|---|---|---|--|--|--|
| | | | Component | | | | | | | | | | |
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Digital right from the core | Digital Culture | .761 | .899 | | | | | | | | | | |
| | Digital workspaces | .652 | .832 | | | | | | | | | | |
| A compelling employer brand | Compete for talent | .708 | | .810 | | | | | | | | | |
| | Organizational Culture | .735 | | .674 | | | | | | | | | |
| | Organization Goodwill | .647 | | .674 | | | | | | | | | |
| New breed of leadership | Spot poor leaders | .916 | | | .785 | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---------------------------------------|------|--|--|------|------|------|--|--|--|--|-------|------|
| | Right environment | .726 | | | .741 | | | | | | | | |
| | Coherent vision | .851 | | | .687 | | | | | | | | |
| Work filled with purpose | Clear purpose with best talent | .664 | | | | .840 | | | | | | | |
| | Sense of purpose with personal values | .825 | | | | .829 | | | | | | | |
| Harnessing the power of Virtual Reality | Collaborative training | .712 | | | | | .891 | | | | | | |
| | Remote working | .762 | | | | | .847 | | | | | | |
| Prioritizing employee experience | Employee experience | .813 | | | | | | | | | | -.734 | |
| | Reinvent skillsets | .724 | | | | | | | | | | .545 | |
| Outsourcing (both to humans and machines) | Freelance projects | .754 | | | | | | | | | | | .800 |
| Agile management | Frequent peer-to-peer feedback | .790 | | | | | | | | | | | .941 |

Extraction Method: Principal Component Analysis.
 Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 10 iterations.

Extraction Method: Principal Component Analysis
 Determinant = .033

Henceforth the dimensions are labeled as

- Dimensions /strategies 1= X₁=Digital right from the core
- Dimensions /strategies 2= X₂= compelling employer brand
- Dimensions /strategies 3= X₃=New breed of leadership
- Dimensions /strategies 4= X₄=Work filled with purpose
- Dimensions /strategies 5= X₅=Harnessing the power of Virtual Reality
- Dimensions /strategies 6= X₆=Prioritizing employee experience
- Dimensions /strategies 7= X₇=Outsourcing (both to humans and machines)
- Dimensions /strategies 8= X₈=Agile management

6.3.2 Reliability and normality check of talent management dimensions that attract & retain Future

Workforce

To validate the internal reliability of the model used, a reliability test (Cronbach's alpha) was applied. While performing the test, each dimension was studied separately to test internal reliability. The test results are shown in Table 6. The Cronbach degrees in each dimension are higher than 0.7, indicating that the dimensions are quite reliable, and the elements related to each dimension can be used to measure the dimensions/constructs involved. Table 6 depicts the estimated reliability of each of the eight talent management dimensions: 0.644, 0.65, 0.611, 0.761, 0.863, 0.704, 0.621, and 0.642 respectively by calculating Cronbach's alpha value. These dimensions are found to have sufficient reliability and hence can be used for further analysis.

6.3.3 Identifying dominant talent strategies for the future of the future work place

Out of 8 talent strategies identified, a compelling employer brand with an average mean score of 11.92 was dominant and compete over other strategies because it describes the company's reputation and popularity. New breed of leadership was opined as a second dominant strategy that cultivated new insights and perspectives. Other strategies are also in the order of importance and contribution which was reported in Table 6.

Table 6. Descriptive statistics of dominant strategies for future work place

| code | Dimensions/strategies | Sum | Mean | Rank | Std. Deviation | Skewness | Kurtosis | Cronbach's alpha |
|----------------|-----------------------------|------|-------|------|----------------|----------|----------|------------------|
| X ₁ | Digital right from the core | 2412 | 8.04 | 3 | 1.35 | -0.76 | -0.10 | 0.644 |
| X ₂ | Compelling employer brand | 2256 | 7.52 | 5 | 1.90 | -0.65 | -0.12 | 0.65 |
| X ₃ | New breed of leadership | 3576 | 11.92 | 1 | 1.93 | -0.25 | -0.15 | 0.611 |
| X ₄ | Work filled with purpose | 2916 | 9.72 | 2 | 2.51 | -0.44 | 0.36 | 0.761 |

| | | | | | | | | |
|----------------|---|------|------|---|------|-------|-------|-------|
| X ₅ | Harnessing the power of Virtual Reality | 1257 | 4.19 | 4 | 0.70 | -0.81 | 1.11 | 0.863 |
| X ₆ | Prioritizing employee experience | 2214 | 7.38 | 6 | 1.23 | -0.37 | -0.30 | 0.704 |
| X ₇ | Outsourcing (both to humans and machines) | 2214 | 7.38 | 6 | 1.23 | -0.37 | -0.30 | 0.621 |
| X ₈ | Agile management | 993 | 3.31 | 7 | 1.07 | -0.29 | -0.81 | 0.642 |

6.3.4 Detecting the interrelationship of talent strategies of the future work place using bivariate analysis - Karl Pearson correlation

Bivariate analysis was undertaken before multiple regression test to find the linear association of the future workplace and its strategies/dimensions explored through a factor analysis that designed the future workplace using Karl Pearson correlation.

Table 7 Output of matrix of the Pearson's correlation coefficient

| code | Dimensions/Strategies | Statistics | Future of Future Workplace |
|----------------|---|-------------------------|----------------------------|
| X ₁ | Digital right from the core | Pearson Correlation | 0.309** |
| | | Significance (2-tailed) | 0.000 |
| X ₂ | Compelling employer brand | Pearson Correlation | 0.515** |
| | | Significance (2-tailed) | 0.000 |
| X ₃ | New breed of leadership | Pearson Correlation | 0.521** |
| | | Significance (2-tailed) | 0.000 |
| X ₄ | Work filled with purpose | Pearson Correlation | 0.596** |
| | | Significance (2-tailed) | 0.000 |
| X ₅ | Harnessing the power of Virtual Reality | Pearson Correlation | 0.368** |
| | | Significance (2-tailed) | 0.000 |
| X ₆ | Prioritizing employee experience | Pearson Correlation | 0.565** |
| | | Significance (2-tailed) | 0.000 |
| X ₇ | Outsourcing | Pearson Correlation | 0.565** |
| | | Significance (2-tailed) | 0.000 |
| X ₈ | Agile management | Pearson Correlation | 0.388** |
| | | Significance (2-tailed) | 0.000 |

Table 7 provides a matrix of the correlation coefficients for the eight variables. Pearson correlation was used in the study. Test of significance was done using

the two-tailed test. The criterion for significance is usually .05 and 0.10. So SPSS marks any correlation coefficient significant at this level with an asterisk. The results exhibit that all eight talent management dimensions measured have significant positive correlation with a profitable future of future work and workplace at 5% and 1% level of significance. The future of work demands these 8 new strategies such as digital right from the core, compelling employer brand, compelling employer brand, new breed of leadership, work filled with purpose, harnessing the power of virtual reality, prioritizing employee experience, and outsourcing (both to humans and machines).

6.4 Identifying the relative contribution of each talent strategy for the future work place:

As mentioned earlier, the future of the workplace is believed to depend on eight dimensions namely digital right from the core, compelling employer brand, compelling employer brand, new breed of leadership, work filled with purpose, harnessing the power of virtual reality, and prioritizing employee experience. Multiple regression was employed to determine relative strength and contribution of these dimensions to the future of work and the new workplace to make work better.

6.4.1 Multiple Regression Analysis

Multiple regression was run to predict future of future workplace from talent management dimensions.

Step 1: Decide whether the association between the response and talent management dimensions is statistically significant.

Statistical significance of the regression model: Analysis of variance (ANOVA) was used to test the statistical significance of R-square value in the model summary table. The null hypothesis was that the population R-square was zero. ANOVA results indicated statistical significant ($F(8, 291) = 10384.315, p < .0005, R^2 = .997$), suggesting that the population R-square was significantly greater than zero. It indicated that talent management dimensions statistically and significantly

predicted the future of the future workplace. All eight dimensions added statistically and significantly to the prediction, $p < .05$. In other words, any given change in one of the talent management dimensions would always produce a corresponding change in the future of the future workplace. Thus all talent management dimensions were confirmed by the analysis to have strong impact on the future work place.

Table 8 ANOVA Table to ascertain the association of the future of the future workplace and talent management dimensions

| Model | | Sum of Squares | Degrees of freedom | Mean Square | F ratio | Significance |
|-------|------------|----------------|--------------------|-------------|-----------|-------------------|
| 1 | Regression | 10387.892 | 8 | 1298.487 | 10384.315 | .000 ^b |
| | Residual | 36.388 | 291 | .125 | | |
| | Total | 10424.280 | 299 | | | |

a. Dependent Variable: Future of Future Workplace

b. Predictors: (Constant), Agile management, Outsourcing (both to humans and machines), Prioritizing employee experience, Harnessing the power of Virtual Reality, Work filled with purpose, New breed of leadership, A compelling employer brand, Digital right from the core

Statistical significance of the talent management dimensions: p-values of the t-test reported in Table 9 to determine whether there was a linear relationship between future of future workplace and each of digital right from the core, compelling employer brand, compelling employer brand, new breed of leadership, work filled with purpose, harnessing the power of virtual reality, and prioritizing employee experience was 0.000 indicating that all dimensions contributed to the model. Therefore, all dimensions were linearly related to the future.

Table 9. Regression Coefficient to predict the future of the future workplace

| code | Model Dimensions / Strategies | Unstandardized Coefficients | | Standardized Coefficients | T statistics | Significance | 95.0% Confidence Interval for B | |
|----------------|---|-----------------------------|------------|---------------------------|--------------|--------------|---------------------------------|-------------|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| | (Constant) | 60.180 | .020 | | 2947.698 | .000 | 60.140 | 60.220 |
| X ₁ | Digital right from the core | 2.733 | .020 | .463 | 133.660 | .000 | 2.693 | 2.774 |
| X ₂ | Compelling employer brand | 2.572 | .020 | .436 | 125.764 | .000 | 2.532 | 2.612 |
| X ₃ | New breed of leadership | 3.046 | .020 | .516 | 148.935 | .000 | 3.005 | 3.086 |
| X ₄ | Work filled with purpose | 1.818 | .020 | .308 | 88.910 | .000 | 1.778 | 1.858 |
| X ₅ | Harnessing the power of Virtual Reality | 2.042 | .020 | .346 | 99.837 | .000 | 2.001 | 2.082 |
| X ₆ | Prioritizing employee experience | .204 | .020 | .035 | 9.989 | .000 | .164 | .245 |
| X ₇ | Outsourcing (both to humans and machines) | 1.126 | .020 | .191 | 55.067 | .000 | 1.086 | 1.166 |
| X ₈ | Agile management | 1.611 | .020 | .273 | 78.783 | .000 | 1.571 | 1.651 |

Dependent Variable: Future of Future Workplace

The intercept and coefficients were interpreted in the usual manner. The intercept $b_0=60.180$ was meaningless in the context of the present study. Statistical significance of each independent variable test whether the unstandardized (or standardized) coefficients was equal to 0 (zero) in the population (i.e. for each coefficient, $H_0: \beta = 0$ versus $H_a: \beta \neq 0$ was conducted). If $p < .05$, the coefficients were statistically and significantly different to 0 (zero). It was used to investigate if each explanatory variable needed to be in the model, given that others were already there. The t-value and corresponding p-value are in the "t" and "Sig." columns (Table 4), respectively. The tests tell us that Digital right from the core $p (.000) < 0.05$, compelling employer brand $p (.000) < 0.05$, New breed of leadership $p (.000) < 0.05$, Work filled with

purpose $p (.000) < 0.05$, harnessing the power of Virtual Reality $p (.000) < 0.05$, Prioritizing employee experience $p (.000) < 0.05$, Outsourcing (both to humans and machines) $p (.000) < 0.05$, and Agile management $p (.000) < 0.05$ were significant. This meant that all talent management dimensions were highly useful in the model. In other words, all talent management dimensions added substantial contributions to explaining or determining the future workplace..

Estimated model coefficients: The common form of the regression equation to envisage the future of the future workplace was:

$$\hat{Y} = 60.180 + 2.733$$

$$X_1 + 2.572X_2 + 3.046X_3 + 1.818X_4 + 2.042X_5 + 0.204X_6 + 1.126X_7 + 1.611X_8$$

Where \hat{Y} = predicted future of future workplace

X_1 = Digital right from the core

X_2 = compelling employer brand

X_3 = New breed of leadership

X_4 = Work filled with purpose

X_5 = Harnessing the power of Virtual Reality

X_6 = Prioritizing employee experience

X_7 = Outsourcing (both to humans and machines)

X_8 = Agile management

This equation was obtained from the (Table 9) above

Unstandardized coefficients indicated how much the future of the future workplace varied with every talent management dimension when holding other dimensions of talent management constant. Overall, the regression coefficient delivered the expected variation in the future of the future workplace for one-unit changes in every talent management dimension. As a result, standardized coefficients were also most useful measures to rank talent management dimensions based on their contribution (nevertheless of sign) in explaining the future of the future workplace. Therefore, at present, New breed of leadership was the uppermost contributing (0.491) predictor to explain the future of the future workplace, and the next was Digital right from the core (0.463). Nevertheless, only when the model was specified perfectly could multicollinearity not be found among the predictors, Stephanie (2018).

Checking multicollinearity: Tolerance and Variance Inflation Factors (VIF) were the most reliable tests for multicollinearity. If multicollinearity occurred between two or more talent management dimensions it could deteriorate the results of multiple regression. Therefore, the presence of co-linearity among talent management dimensions was examined using Tolerance and VIF before running the multiple regression model. Values of VIF that were beyond 10 were viewed as indicative of multicollinearity. Weisburd & Britt state that tolerance under 0.20 suggested serious multicollinearity in a model. Table 10 reports the Collinearity Statistics.

Table 10. Tolerance value and variance inflation factors (VIF)

| | Talent Management dimensions | Collinearity Statistics | |
|----------------|---|-------------------------|---------------------------------------|
| | | Tolerance | VIF $= \frac{1}{\text{Tolerance}}$ |
| X ₁ | Digital right from the core | 0.801 | 1.2484 |
| X ₂ | Compelling employer brand | 0.821 | 1.2180 |
| X ₃ | New breed of leadership | 0.731 | 1.3680 |
| X ₄ | Work filled with purpose | 0.537 | 1.7640 |
| X ₅ | Harnessing the power of Virtual Reality | 0.636 | 1.5723 |
| X ₆ | Prioritizing employee experience | 0.695 | 1.4388 |
| X ₇ | Outsourcing (both to humans and machines) | 0.697 | 1.4347 |
| X ₈ | Agile management | 0.835 | 1.1976 |

From Table 10, it is clear that the tolerance of eight independent variables ranged between 0.537 and 0.835 and were substantially greater than 0.1 while VIF ranged from 1.1976 to 1.764 and was lower than 2. Therefore, the result proposed that the present study did not find any multicollinearity. This was also in agreement with the standard interpretation of the regression coefficients. There was no need to create a new dimension or delete one of the dimensions. (predictor variables).

Step 2: Determine how well the model fits data

Researcher tests the goodness-of-fit statistics in the model summary table to determine how well the model fits the data. R represents the multiple correlation coef-

ficient. Its large value, 0.998 indicates a strong relationship between the future of the future value and talent management dimensions. R-squared was used to evaluate how well the model comprehended the response about the future of the future work place in relation to talent management dimensions. An R-squared of 0.997 revealed that 99.7% of data fit the regression model thereby indicating better fit for the regression model. The adjusted R-squared value of 0.882 again showed the predictive power of the independent variables. The Durbin-Watson $d=2.074$, which was between the two critical values of $1.5 < d < 2.5$. It pointed out that there was no evidence of first order linear auto-correlation in the multiple linear regression data.

Table 11. Model Summary

| Model | R | R Square | Adjusted R Square | Standard Error of the Estimate | Durbin-Watson |
|-------|-------|----------|-------------------|--------------------------------|---------------|
| 1 | 0.998 | 0.997 | 0.882 | 0.35361 | 2.130 |

Step 3: Decide whether multiple regression model accomplished the assumptions of the analysis

Researcher used the residual plots to decide whether the model was acceptable and fulfilled the assumptions of the analysis. The normal probability plot of residuals verified the assumption that the residuals were normally distributed. The normal probability plot of the residuals should almost follow a straight line. In this normal probability plot (Fig.2), the points normally followed a straight line. There was no signal of non-normality, outliers, or unidentified variables.

workplace)

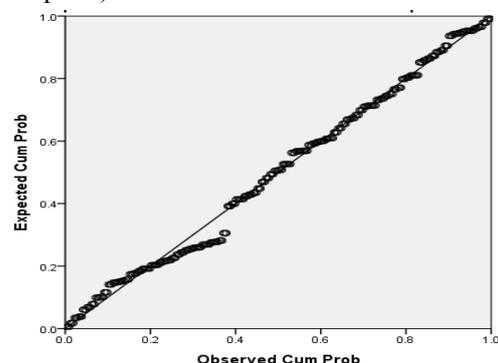


Fig 2. Normal P-P Plot of Regression Standardized Residual (Dependent variable: future of future workplace)

Fig 3 shows a histogram of the standardized residuals. The shape of the histogram of the standardized residuals indicated that residuals exhibited only a minor departure from normality.

By overseeing the assumptions and relative results, it was understood that the data was fit to carry out the regression analysis.

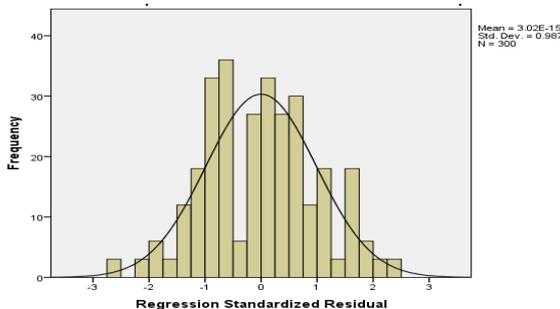


Fig 3. Histogram of the standardized residuals and shape (Dependent variable: future of future workplace)

7. Gender effect on the future of the future work pertaining to talent management dimensions / strategies

Women were more likely to improve their career prospects compared to men. They had a better chance of cracking deals. They remained constantly in the success stream. Women were found to be confident about their performance at the workplace compared to men. Using independent t-test, researchers attempted to infer the gender effect on future work pertaining to talent strategies. While reviewing the mean score, all dimensions pertaining to future workplace, women employees were more invariably supportive than male employees.

Table 12 reported that sig of t-test for Equality of Means and Levene's Test for Equality of Variances were greater than 0.05. It signified acceptance of the null hypothesis that there was no variance in the opinions of male and female employees. Though they did not differ in their understanding, recognition of all talent strategies determined the future of the workplace. So, whether male and female, it was time to be confident and flaunt their achievements. They did not differ as they understood the future work pattern. They were being proud of their achievements and this was what they were paid for.

Table 12. Gender effect on future of future work pertaining to talent strategies

| Dimensions | Gender effect | Mean | Std. Deviation | Levene's Test for Equality of Variances | | t-test for Equality of Means |
|---|---------------|--------|----------------|---|------|------------------------------|
| | | | | F | Sig. | Sig. (2-tailed) |
| Digital right from the core | Male | 2.4154 | .98254 | .726 | .395 | .587 |
| | Female | 2.5057 | 1.03287 | | | |
| Compelling employer brand | Male | 2.0308 | .95147 | .080 | .778 | .081 |
| | Female | 2.2989 | .91645 | | | |
| New breed of leadership | Male | 3.4769 | .81217 | .122 | .728 | .766 |
| | Female | 3.5172 | .83335 | | | |
| Work filled with purpose | Male | 3.5846 | .68219 | .092 | .762 | .989 |
| | Female | 3.5862 | .70796 | | | |
| Harnessing the power of Virtual Reality | Male | 3.9538 | .75892 | 1.103 | .295 | .373 |
| | Female | 4.0690 | .80396 | | | |
| Prioritizing employee experience | Male | 3.9077 | .78508 | 1.440 | .232 | .394 |
| | Female | 4.0115 | .70701 | | | |
| Outsourcing (both to humans and machines) | Male | 3.9385 | .63435 | .054 | .817 | .056 |
| | Female | 4.1264 | .56660 | | | |
| Agile management | Male | 3.6462 | .89147 | 2.990 | .086 | .317 |
| | Female | 3.7816 | .76895 | | | |

8. Conclusion

Unique Unique talent strategies are very y important for IT professionals dealing with software and hardware, and client management. Creating a comprehensive talent management strategy for future work and the workplace is a major undertaking. To design satisfying strategies, companies need to take note of talent strategies that impact the future workplace. Organization Goodwill, Collaborative training, Organizational Culture, Clear purpose with best talent and introduction of Freelance projects as per demand and requirement were identified as strong influencers in developing future workplace strategy. Exploratory factor analysis resulted in eight dimensions which were unearthed from previous literature. These were found to be Digital right from the core, compelling employer brand, New breed of leadership, Work filled with purpose, Harnessing the power of Virtual Reality, Prioritizing employee experience, Outsourcing (both to humans and machines), and Agile management. These eight dimensions together explain a total variance of 75.26%. The results obtained from Cronbach's alpha reported that all eight dimensions possessed adequate reliability. Karl Pearson correlation results also confirmed the interrelationship of all dimensions towards future workplace talent strategy. Further,

multiple regression was used to investigate relative contribution. New breed of leadership contributed the most toward future workplace talent strategies. Female employees were more supportive of all strategies shaped by employee wellbeing priorities. However, they had the same level of option and perception about workplace strategies of the future. Surely Strategies of the Past and Innovations for the Future will support this eight dimensions' model to realize inclusive growth and tackle the rapidly approaching global talent crisis. Last, digitalization and technology will promote new methods of working and finally indispensable competencies in the organization will have excessive focus on service based and/or product based information technology (De Bruyne, E. and Gerritse, D. 2018).

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Diffusion of Innovation and Viability of Hospitals - An Empirical Study

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Abstract

Though the impact of innovation on firms' performance is a widely studied topic, there is a dearth of research on this topic specific to private hospitals in India. The objectives of this study were to assess the diffusion of innovation among private hospitals, to examine the relationship between innovation adoption and viability of private hospitals and to examine variations in diffusion of innovation across various categories of private hospitals. This was a quantitative study conducted among 154 private hospitals in Kerala in Jan 2021. Responses to 4 statements related to innovation and 3 statements related to viability were captured using a 5 point Likert scale. Bivariate correlation results indicated that there is a positive correlation between adoption of innovative practices by hospitals and their viability. Variations in diffusion of innovation across types of hospitals were examined using independent sample t-test or ANOVA. Hospitals with specialty services, hospitals with inpatient facility, hospitals located in urban areas and newer hospitals were seen to be more open to adopting innovative practices. Findings of the study have significant implications to hospitals. Since innovation is seen to have an impact on viability it is important that hospitals adopt innovative practices in healthcare.

Key words: Diffusion of innovation, Healthcare innovation, Hospitals, Viability.

1. Introduction

Healthcare innovation is about finding new and more effective ways of solving healthcare problems. The aim of healthcare innovation is to provide accessible, affordable and sustainable healthcare at personal and public level and also to improve quality, safety, effectiveness and efficiency of healthcare solutions. Innovation can be in the area of technology, policies, systems, products, services or ideas. For the many innovations in the healthcare sector to be considered useful, they need to penetrate far enough to reach the end consumers i.e. patients. This can happen only through diffusion of innovation among hospitals. It needs to be noted that while innovations in diagnosis and treatment of diseases is critical for quality, safety and effectiveness of healthcare delivery, it is innovations in management practices, cost control and patient management that ensures accessibility and affordability of healthcare services. Hence adoption of innovative practices by hospitals in all these areas is equally important. It is important to assess diffusion of innovation in our hospitals to understand if patients actually stand to benefit from the many healthcare innovations. Private hospitals in the country operate in a business environment that is characterized by fierce competition that makes their survival challenging. From an organisational point of view, the ultimate test for effectiveness of hospital innovations would be its impact on the viability of hospitals. Examining the

relationship between innovation and viability of hospitals can help us appreciate the importance of innovation for healthcare providers.

2. Review of Literature

Harvard Business Review (2003) defines innovation as the embodiment, combination or synthesis of knowledge in original, relevant and valued new products, processes or services. Schweitzer F et. al. (2015) classify healthcare innovations as social innovations as they aim to solve problems related to health, which is a social issue. According to WHO, health innovation refers to practices that identify better policies, technologies, products, systems and delivery methods to improve health and wellbeing of the population, especially those of vulnerable populations. **Types of hospital innovations:** Innovations in hospitals can be of varying kinds: In their review of literature on hospital innovations Djellal and Gallouj (2007) state that other than technological innovations hospitals can have organisational innovations (e.g. changes in organizational structure to improve healthcare delivery), managerial innovations (e.g. changes in administrative practices or financial management systems), relational or service innovations (e.g. quality of patient facilities, reduction in waiting time), social innovations (e.g. experiments with internal communications) and innovations in external re-

lations (e.g. establishment of specific relations with stakeholders). Herzlinger R.E. (2006) opines that three types of innovation in healthcare are needed to make it better and cheaper: changes in technology, new business models and delivery (the way patients buy and use healthcare services).

Significance of healthcare innovations – from patient perspective: Christensen C (2017) strongly suggests that only disruptive innovations can make healthcare affordable and accessible. Mazumdar (2018) stated that only affordable innovations in healthcare can ensure affordability and accessibility to healthcare on a sustainable basis.

Significance of healthcare innovations – from the perspective of hospitals: Health economics holds hospital as a firm like any other and Phelps (2017) goes even further, with his concept of ‘physician-firm’. Innovations are important for firms of any kind. Studying the impact of innovation on performance of Vietnamese firms from 2005–2015, Mai A.N. et. al. (2019) concluded that innovators achieve higher profit in comparison with non-innovating firms. Innovation begins with creative ideas. Minor B et. al. (2017) conducted a study to explore the relation between ideation rate (number of ideas per one thousand employees) and productivity of 28 public companies between 2014 and 2016 and found a significant correlation between the ideation rate and growth in profit or net income. Similar pattern was observed across different industries including health care companies. In fact highest ideation rate was observed in a large health care company whose net profit grew 6% over the two years of study. Analysing medicare data of 2.8 million patients from 1986 to 2004 in the US, Skinner and Staiger (2015) noticed that small differences in the adoption of effective technology lead to big differences in productivity across hospitals. Salge and Vera (2009) studied 173 hospitals in the National Health Service network in England and found higher levels of science and practice based innovativeness to be associated with better quality of healthcare delivery. However such an association of innovativeness was not noticed in the case of financial performance or administrative performance of hospitals.

Factors that influence diffusion of innovation in hospitals: Several factors influence adoption of innovation by hospitals. Blank and Valdmanis (2003) studied innovation diffusion in 60 Dutch hospitals and concluded that size of the hospitals, competition and commitment of the hospital to innovation were positively correlated to diffusion of hospital innovations. Relationship between organizational size and innovation was further confirmed by Neystrom et. al. (2002) who studied 70 hospitals to explore the influence of organizational climate on innovativeness and concluded that organizational size is positively related with innovativeness. Studying the diffusion of breast conserving surgery in medical communities, Jerome-D’Emilia and Begun (2005) stated that variations exist across types of hospitals – it was highest in academic teaching hospi-

tals and lowest in community hospitals in the US. The authors assert that social and cultural norms strongly influence diffusions of innovation. Influence of cultural attitudes in diffusion of innovation was also highlighted by Hashimoto et. al. (2006) in their study where they compared diffusion of stenting technology usage in a teaching hospital in the U.S. with a similar hospital in Japan. Adoption of innovation can even be triggered by association with prominent doctors. Examining association of stent technology adoption by ‘non star’ doctors to the number of ‘star’ doctors in their peer group, Burke and Prasad observed that the diffusion of stent by non-stars depends positively on the number of stars practicing at the same hospitals (star is defined as a doctor who completed residency at a top-ranked hospital). Collaboration among hospitals can enhance diffusion of innovation among hospitals. Goes and Park (1997) studied 400 hospitals in California for over 10 years and found out that structural, institutional and resource based associations among hospitals enhance adoption of innovation in hospital services and technologies. Herzlinger RE (2006) states that the factors that affect diffusion of innovation in healthcare include stakeholders and their interests, government policies and regulations, availability of funding, cost of innovation and competition.

Viability of healthcare organizations: Sergio et. al. (2014) proposed Viable Systems Approach (VSA) as a model to study viability and sustainability of healthcare organizations. In the Viability Systems Approach (VSA) systems are said to be viable when they are oriented towards the final goal of survival (Beer S, 1984, 1985).

3. Research Gap

Though the impact of innovation on a firms’ performance is a widely studied topic, there is a dearth of research on this topic specific to allopathic private hospitals in India. Studies on impact of innovation on hospital performance focus either on one or a combination of performance parameters as hospital productivity, quality of healthcare delivery, administrative productivity, financial performance, cost of healthcare delivery etc. The impact on all these in their totality viz. ‘viability’ of hospitals has not been studied as yet. Numerous studies have established differentiated diffusion based on type of innovation but these variations across types of hospitals have not been studied in the Indian context. This paper attempts to cover these research gaps.

4. Statement of Problem

Innovations in healthcare are meant to improve its quality, affordability and accessibility. To assess if these innovations are reaching the end consumers, diffusion of innovation among hospitals need to be examined as hospital is the channel through which these innovations would reach

the patients. Variations across different categories of hospitals that target different segments of people need to be examined to understand if the distribution of advancements in the sector is equitable among patients. From a hospital perspective it needs to be examined to what extent adoption of innovation contributes to its viability. This paper attempts to address these research issues.

5. Research Objectives

The objectives of the study are:

- To assess the diffusion of innovation among private hospitals.
- To examine the relationship between innovation adoption and viability of private hospitals.
- To examine variations in diffusion of innovation across various categories of private hospitals.

6. Hypotheses

In the context of a hospital, the four main areas for innovation are diagnosis and treatment, patient management, cost control and administration. The impact of adoption of innovative practices in each of these on the viability of hospitals needs to be examined as this would help in getting a comprehensive picture of the relationship between innovation and viability. Hence the following hypotheses are proposed:

Hypothesis 1: Innovation in diagnosis and treatment has no correlation with viability of hospitals.

Hypothesis 2: Innovation in management of patients has no correlation with viability of hospitals.

Hypothesis 3: Innovation in cost control has no correlation with viability of hospitals.

Hypothesis 4: Innovation in administration, marketing and other areas of management has no correlation with viability of hospitals.

Hypothesis 5: Adoption of innovative practices in general has no correlation with viability of hospitals.

7. Research Methodology

This was a quantitative study that was conducted using survey method. Target respondents were doctors who were either consulting doctors in hospitals or proprietors of clinics or hospitals. Sampling frame was a list of all doctors who were registered with I Safe program of IMA, Kerala branch. This numbered to 935 hospitals. All the doctors in the sampling frame were contacted with a request to participate in the survey. 154 doctors chose to participate. Regional distribution of these hospitals is as follows: North Kerala: 53, Central Kerala: 52, South Kerala: 47, Total: 154 (region was not mentioned in 2 cases). Questionnaire was made in Google form and pi-

lot tested among 10 respondents to check for ease of administration and comprehensibility of scale items. The questionnaire was then shared in the social media platform of doctors in the sampling frame. A few face to face interviews were conducted wherever possible, though the number of such interviews was limited due to the COVID19 pandemic situation.

Analysis: Bivariate correlation was used to assess correlation between innovation and viability. To examine the correlation between innovation and viability, an 'innovation score' and a 'viability score' were calculated for each hospital.

Calculation of 'innovation score': Four statements were used to assess adoption of innovative practices by hospitals. These statements were:

1. My hospital adopt innovative practices in diagnosis and treatment.
2. My hospital adopt innovative practices in management of patients.
3. My hospital adopt innovative practices in cost control.
4. My hospital adopt innovative practices in administration, marketing and other areas.

A five point Likert scale was used to assess the extent to which doctors agreed with the above statements. A score of '5' was given for 'strongly agree', '4' for 'agree', '3' for 'neither agree nor disagree', '2' for 'disagree' and '1' for 'strongly disagree'. Based on the responses to each of the above statements related to innovation, an average 'innovation score' was calculated for each hospital.

Calculation of 'Viability Score': Viability of hospitals was assessed on the basis of doctors' responses to three statements related to viability. The statements were:

1. I consider my hospital to be viable (has enough income to cover operating costs and debts and sustain / grow business)
2. I am confident of running this hospital profitably as long as I wish to
3. I am confident of facing competition (from other hospitals, big and small) at present and in future.

A 5 point agree-disagree Likert scale was used in this case also and an average viability score was calculated for each hospital based on the responses for the three statements listed above.

Variation in adoption of innovative practices across different categories of hospitals was assessed using independent sample t-test or ANOVA depending on the number of levels of independent variables.

8. Scope of the Study

Geographically the study was limited to Kerala, the state that is consistently ranked highest in health index among all states in the country by NITI Aayog. Taking Kerala as an exemplary state in health achievements, diffusion of innovation in hospitals in Kerala was studied. The study was confined to modern medicine hospitals in the private sector as this form the major chunk of healthcare delivery system in the country. Hospitals covered in the study mostly provided primary and secondary care.

9. Findings

Adoption of innovative practices by hospitals is captured in the following descriptive statistical data.

Table 1. Adoption of Innovative Practices by Private Hospitals

| Adopt innovative practices in: | | Frequency | Percent | Mean Score |
|--------------------------------|----------------------------|-----------|---------|------------|
| Diagnosis and treatment | Strongly Disagree | 5 | 3.3 | 3.7 |
| | Disagree | 9 | 5.9 | |
| | Neither agree nor disagree | 30 | 19.7 | |
| | Agree | 85 | 55.9 | |
| | Strongly agree | 23 | 15.1 | |
| | Total | 152 | 100.0 | |
| Patient Management | Strongly Disagree | 5 | 3.3 | 3.6 |
| | Disagree | 13 | 8.6 | |
| | Neither agree nor disagree | 37 | 24.3 | |
| | Agree | 79 | 52.0 | |
| | Strongly agree | 18 | 11.8 | |
| | Total | 152 | 100.0 | |

| | | | | |
|------------------------------|----------------------------|-----|-------|-----|
| Cost Control | Strongly Disagree | 9 | 6.0 | 3.6 |
| | Disagree | 8 | 5.3 | |
| | Neither agree nor disagree | 35 | 23.3 | |
| | Agree | 78 | 52.0 | |
| | Strongly agree | 20 | 13.3 | |
| | Total | 150 | 100.0 | |
| Administration and Marketing | Strongly Disagree | 17 | 11.3 | 3.2 |
| | Disagree | 16 | 10.7 | |
| | Neither agree nor disagree | 55 | 36.7 | |
| | Agree | 47 | 31.3 | |
| | Strongly agree | 15 | 10.0 | |
| | Total | 150 | 100.0 | |

As indicated by the mean scores, innovative practices are most adopted for diagnosis and treatment of diseases. Hospitals adopt innovation to the same extent for cost control and patient management. However, in comparison, innovation is adopted to a lesser extent in administration and marketing.

9.1 Testing of Hypotheses

For testing the hypotheses, viability score of the hospital was taken as the dependent variable in all cases. Statistical tool used was bivariate correlation.

Table 2. Correlation between Viability and Innovation Scores

| | Viability Score | Innovation in Diagnosis and Treatment |
|---------------------|-----------------|--|
| Pearson Correlation | 1 | .283** |
| Sig. (2-tailed) | | .000 |
| N | 154 | 152 |
| | | Innovation in Patient Management |
| Pearson Correlation | 1 | .328** |
| Sig. (2-tailed) | | .000 |
| N | 154 | 152 |
| | | Innovation in Cost Control |
| Pearson Correlation | 1 | .258** |
| Sig. (2-tailed) | | .001 |
| N | 154 | 150 |
| | | Innovation in Administration and Marketing |
| Pearson Correlation | 1 | .142 |
| Sig. (2-tailed) | | .083 |
| N | 154 | 150 |
| | | Innovation Score |
| Pearson Correlation | 1 | .280** |
| Sig. (2-tailed) | | .000 |
| N | 154 | 152 |

Hypothesis 1: Innovation in diagnosis and treatment has no correlation with viability of hospitals.

Independent variable: Rating for the statement ‘My hospital adopt innovative practices in diagnosis and treatment’.

p value is 0.000 (< 0.05). Null hypothesis is rejected. Innovation in diagnosis and treatment has correlation with viability of hospitals. Pearson correlation coefficient of .283 indicates a small correlation with viability.

Hypothesis 2: Innovation in management of patients has no correlation with viability of hospitals.

Independent variable: Rating for the statement ‘My hospital adopt innovative practices in management of patients’.

p value is 0.000 (< 0.05). Null hypothesis is rejected. Innovation in management of patients has correlation with viability of hospitals. Pearson correlation coefficient of .328 indicates moderate correlation with viability.

Hypothesis 3: Innovation in cost control has no correlation with viability of hospitals.

Independent variable: Rating for the statement ‘My hospital adopt innovative practices in cost control’.

p value is 0.001 (< 0.05). Null hypothesis is rejected. Innovation in cost control has correlation with viability of hospitals. Pearson correlation coefficient of .258 indicates a small correlation with viability.

Hypothesis 4: Innovation in administration, marketing and other areas of management has no correlation with viability of hospitals.

Independent variable: Rating for the statement ‘My hospital adopt innovative practices in administration, marketing and other areas’.

p value is 0.083 (> 0.05). Null hypothesis is not rejected. Innovation in administration, marketing and other areas of management has no correlation with viability of hospitals.

Hypothesis 5: Adoption of innovative practices in general has no correlation with viability of hospitals.

Independent variable: Innovation score

p value is 0.00 (< 0.05). Null hypothesis is rejected. Adoption of innovative practices in general has correlation with viability of hospitals. Pearson correlation of 0.280 indicates a small correlation with viability.

9.2 Variations in Diffusion of Innovation across Hospital Categories

It is established that adoption of innovative practices is important in ensuring viability of hospitals. This made it necessary to examine the adoption of innovation across various categories of hospitals. For this, innovation score of the hospital was taken as the dependent variable (DV). Depending on the levels of the independent variables (IV) either ANOVA or independent sample t-test

was used to understand the variations in innovation across different categories of hospitals.

Innovation Score: Variation between Hospitals with In-patient Facility and Hospitals without In-patient Facility

Table 3. Innovation Scores: Hospitals with and without Inpatient Facility

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|----|------|----------------|-----------------|
| Hospitals with in patient facility | 64 | 3.7 | 1.005 | .126 |
| Hospitals with only outpatient facility | 88 | 3.4 | .741 | .079 |

Innovation score of hospitals with inpatient facility is higher.

Table 4. Variations in Innovation Scores: Hospitals with and without In-patient Facility

| | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | |
|-----------------------------|---|------|------------------------------|---------|-----------------|-----------------|-----------------------|
| | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| Equal variances assumed | 4.127 | .044 | 1.874 | 150 | .063 | .265 | .142 |
| Equal variances not assumed | | | 1.788 | 110.215 | .077 | .265 | .148 |

Levene's Test for Equality of Variances: Sig. 0.044 (< 0.05). Null hypothesis is rejected. There is significant difference in innovation scores of hospitals with inpatient facility and hospitals with only outpatient facility.

Innovation Score: Variations across Types of Hospitals

Table 5. Innovation Score: Hospitals with Specialty and General Medical Services

| | N | Mean | Std. Deviation | Std. Error |
|--------------------------------|----|-------|----------------|------------|
| General medical service only | 52 | 3.284 | 0.828 | 0.115 |
| Specialty medical service only | 43 | 3.797 | 0.570 | 0.087 |

| | | | | |
|--|-----|-------|-------|-------|
| Offers both general and specialty services | 57 | 3.575 | 1.026 | 0.136 |
| Total | 152 | 3.538 | 0.869 | 0.070 |

Mean innovation score is highest for hospitals with only specialty service. Hospitals with specialty service, even if it is along with general medical service are seen to be more innovative (as indicated by the mean of their innovation scores) than hospitals with only general service.

Table 6. Analysis of Variance of Innovation Scores: Hospitals with Specialty and General Medical Services

| ANOVA | | | | | |
|----------------|----------------|-----|-------------|-------|------|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 6.314 | 2 | 3.157 | 4.369 | .014 |
| Within Groups | 107.656 | 149 | .723 | | |
| Total | 113.970 | 151 | | | |

p value is 0.014 (<0.05). There is significant difference in innovation scores across different types of hospitals.

Innovation Score: Regional Variations (Hospitals Located in South, Central and North Regions of Kerala)

Table 7. Innovation Scores: Hospitals in South, Central and North Kerala

| | N | Mean | Std. Deviation | Std. Error |
|---------|-----|-------|----------------|------------|
| South | 47 | 3.676 | 0.895 | 0.131 |
| Central | 50 | 3.450 | 0.773 | 0.109 |
| North | 53 | 3.472 | 0.934 | 0.128 |
| Total | 150 | 3.528 | 0.871 | 0.071 |

Mean innovation score for South is highest. Though North Kerala is considered slightly backward in comparison to other parts of the state, it is interesting to note that mean innovation score for hospitals in North Kerala score is marginally higher than that of Central Kerala (where 'progressive' districts as Ernakulam and Kottayam are located).

Table 8. Analysis of Variance of Innovation Scores: Hospitals in South, Central and North Kerala

| ANOVA | | | | | |
|----------------|----------------|-----|-------------|------|------|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 1.495 | 2 | .748 | .986 | .375 |
| Within Groups | 111.447 | 147 | .758 | | |
| Total | 112.942 | 149 | | | |

Analysis of variance shows that the difference in innovation scores across the three regions – southern, central and northern parts of the state – is not very significant.

Innovation Score: Regional Variations (Hospitals Located in Urban, Semi urban and Rural Regions of Kerala)

Table 9. Innovation Scores: Hospitals in Urban, Semi urban and Rural Areas

| | N | Mean | Std. Deviation | Std. Error |
|------------|-----|-------|----------------|------------|
| Urban | 38 | 3.921 | 0.590 | 0.096 |
| Semi urban | 56 | 3.455 | 0.991 | 0.132 |
| Rural | 58 | 3.366 | 0.831 | 0.109 |
| Total | 152 | 3.538 | 0.869 | 0.070 |

As expected, mean innovation score was highest for hospitals in urban areas followed by semi urban areas and rural areas.

Table 10 Analysis of Variance of Innovation Scores: Hospitals in Urban, Semi urban and Rural Areas

| ANOVA | | | | | |
|----------------|----------------|-----|-------------|-------|------|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 7.666 | 2 | 3.833 | 5.373 | .006 |
| Within Groups | 106.303 | 149 | .713 | | |
| Total | 113.970 | 151 | | | |

p value of 0.006 (<0.05) indicate that variation in innovation score is significant between hospitals in urban, semi urban and rural areas.

Innovation Score: Variations across Newer and Older Hospitals

Table 11. Innovation Scores: Newer and Older Hospitals

| | N | Mean | Std. Deviation | Std. Error |
|--------------------|-----|-------|----------------|------------|
| 1 to 10 years | 59 | 3.729 | 0.772 | 0.100 |
| 11 to 20 years | 29 | 3.586 | 0.676 | 0.125 |
| More than 20 years | 64 | 3.340 | 0.991 | 0.124 |
| Total | 152 | 3.538 | 0.869 | 0.070 |

As expected, newer hospitals score better in innovation score than the older ones. Hospitals that were 1 to 10 years old had a mean innovation score of 3.729, those that were 11 to 20 years old had a mean score of 3.586 and even older hospitals had a mean score of 3.34.

Table 12. Analysis of Variance of Innovation Scores: Newer and Older Hospitals

| ANOVA | | | | | |
|----------------|----------------|-----|-------------|-------|------|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 4.729 | 2 | 2.364 | 3.225 | .043 |
| Within Groups | 109.241 | 149 | .733 | | |
| Total | 113.970 | 151 | | | |

$P = 0.043 < 0.05$. There is significant difference in innovation scores across hospitals of different age categories.

10 Discussion

An ‘innovation score’ (that was reflective of diffusion of innovation in the hospital) and a ‘viability score’ (that was indicative of the perceived ability of the hospital to stay viable or survive) was calculated for each hospital to examine the correlation between innovation and viability. Adoption of innovative practices in general has a direct correlation with viability of hospitals. Coming to the specifics, while innovations in diagnosis and treatment, management of patients and cost control have direct correlation to viability of hospitals, innovation in administration, marketing and other areas of management was found to have no correlation to viability of hospitals. Hospitals with specialty service, even if it is

along with general medical service are seen to be more innovative (as indicated by the mean of their innovation scores) than hospitals with only general service. Coming to regional variations in diffusion of innovation, hospitals in South Kerala scored highest, though the difference was not significant compared to the center and north. As was expected, adoption of innovation by hospitals in urban areas was more compared to semi urban and rural areas and the difference was significant. Newer hospitals were faster to adopt innovation compared to older hospitals. There was significant difference in innovation scores of hospitals with inpatient facility and hospitals with only outpatient facility.

11 Managerial Implications

Findings of the study have significant implications to hospitals. Since innovation is seen to have an impact on viability it is imperative that hospitals adopt innovative practices. Surprisingly, adoption of innovative practices in patient management was seen to have more correlation to viability than use of innovation in diagnosis and treatment. This could probably be because the hospitals that were covered in the study mostly offered primary and secondary medical care. It follows that such hospitals need to focus on improving patient experience. Innovative ways can be adopted to reduce waiting time, easy retrieval of patient data, remote monitoring of patients, ease of taking appointments and making payments and so on. Adopting innovative practices in cost control has an impact on viability and if hospitals practice this and pass the cost savings onto the patients it can go a long way in making healthcare more affordable.

12 Limitations and Future Scope

Ideally financial measure of viability should have been considered in the study, but financial records of hospitals are not easily available, hence non-financial measure of viability had to be considered. The study revealed that adopting innovative practices in diagnosis and treatment, management of patients and cost control have a direct impact on viability of hospitals. An explanatory qualitative research to identify specific innovative practices adopted by hospitals in each of these areas can take this research further. Impact of organisational innovations, relational innovations, social innovations and innovations in external relations on hospital viability can also be explored.

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Technology, Future of Work and Ageing Workforce Readiness

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Abstract

Technological innovation and working patterns have a strong correlation. Advancements in technology and the availability and use of tech power have been the single most important tool in the hands of humanity to contrivance normality in the ongoing pandemic era. However, this reliance on technology has proved especially challenging for the grey population. In fact, ageism and misconstructions regarding older adults among employers is a major barrier faced by older people to continue working or to re-join the workforce. Taking this vital issue as the starting of analysis, this paper explores the challenges and options for integrating the geriatric population with the new demands of the workplace that alter in line with the new technological advancements. In envisioning the future of work, there is a need to also focus on the purposeful and inclusive aspects of work – employee well-being and employee engagement that keeps in mind the role and resourcefulness of employees of all age groups. The five generation workforce is a new emerging reality. If economic growth has to be maintained, employers and governments must take full cognizance of the productive capacity of older workers. Elderly workers have to be prepared for the skills that will be needed in the new and future digital-age careers.

Keywords: Ageing Workforce, Future of Work, Public Policy, Technology;

1. Introduction

As the world advances in economic development and both emerging and mature economies gain a strong foothold in the world economy, a central challenge looms large over the global workforce: ageing workforce readiness. People are living longer and healthier and ageing population is now a global phenomenon. The demographic transition might be going through different stages in different parts of the world but there are universal concerns related to the participation of the older people in the labor market; the sustainability of social protection systems; the availability of quality long term health care; and the rights of elderly people in the society in general (United Nations, 2008).

Nearly every country in the world is experiencing a growth in the size and proportion of older persons in their population.

There were 703 million persons aged 65 years or over in the world in 2019. The number of older persons is projected to double to 1.5 billion in 2050. Globally, the share of the population aged 65 years or over increased from 6 per cent in 1990 to 9 per cent in 2019. That proportion is projected to rise further to 16 per cent by 2050, so that one in six people in the world will be aged 65 years or over (UN Stats).

Although the impact of ageing population can be seen in family systems, health, housing and social services, it is in the realm of work and productivity that the bearing is utmost challenging for most societies. Ageing population will have significant implications in terms of the demand for skilled labor and a shrinking workforce.

The issue of ageing population and the retention of older workers in active employment is considered as one of the most significant issues facing the business and industrial world in major parts of the world.

The issue of aging workforce gets further convoluted with the new and emerging technologies that are disrupting the world of work at a faster pace than anyone could imagine. Older workers are stereotyped as lacking in the ability and confidence needed to effectively engage with innovative technologies. According to Fleming et al. (2017), ageism is so deeply entrenched in the mindset of people that any discussion on ‘technology at work and age’ is always skewed in favor of the young. Many of the reskilling and upskilling training practices in organizations have been sluggish in taking into account the needs of the older workers (Lazazzara and Bombelli, 2011; Young, 2013). This further exacerbates the gap that already exists between the technological adaptation capabilities of those who grew up before the dawn of modern technology and those who have had technology as a ubiquitous part of their lives (Prensky, 2001a, b).

In assessing the challenges or options of the aging workforce, there are different lenses through which organizations view the issue. There are organizations that feel contingent workforce is the key to competitive advantage through short service and high turnover. Thus the organization relies on short term employment and sourcing the skills for a limited period to meet business goals. Other organizations believe that long service and low turnover creates a competitive advantage. Such organizations bank on the experience and specialist skills or relationships which are hard to be replaced easily and produce a competitive pool of top talent. These companies stand to benefit the most from the aging of population and keep up the profits running in the long term as compared to the companies that rely on contingent workforce and will be facing challenges as the workforce becomes older and scarcer (Mercer, 2020).

The strength of older workers lies in their critical knowledge of the domain specific work and the savings in terms of the relative cost of training a new worker (Stachova, 2013). In fact, Timmons et al. (2012) opine that the exit of older workers from the workforce is leading to a ‘labor drain’ wherein the businesses lose the results-driven, idealistic and people-oriented work characteristics possessed by experienced workers. Moreover, older employees mean enrichment for the

organization and their retention or re-employment does not constitute a disproportionate financial burden for the organizations. An overwhelming 76 percent of businesses monitored in Czech Republic reported no impact on wage funds due to hiring of older workers (Cermakova, 2015). The study also highlighted the benefits of age management for organizations in terms of retaining key employees and a visible improvement in the motivation and work performance of employees in all age groups. Other related benefits include – improving organizational climate and culture; employer brand building; and better crisis management (Urbancova and Fejfarova, 2017).

However, in the study of older workers, there is a basic semantic difficulty. The difficulty revolves around setting the point at which a worker is considered old which adds to the woes of both the employer and the employee. Given that life expectancy statistics have shown an upward trend across the world, there exist hazy boundaries of who and when should be counted as an older worker. There is no unanimously agreed upon definition of the category of ‘older workers’. In the Australian Ageing Workforce Report 2019, the findings suggest considerable variability in people’s perceptions of who is an ‘older worker’, with answers ranging from 30 to 80 years of age (Aging Workforce Report, 2019). The most widely shared perspective considers a 65 year old as an older worker. Only a small percentage of people consider that there is no particular age to be considered old. The commonplace conception is that the aging is happening due to the baby boom in the post-world war era. However, it is not so much about baby boomers but more about a function of life expectancy, living longer and healthier. The proportion of people in their infirm years is actually shrinking. People are living healthier for long and in perfect shape and mind to work. However ageism in the world of work is a sad reality. Age discrimination is endemic and technological shifts in the world of work are fuelling it further. This is more so than racism or gender based discrimination because age based discrimination has a social sanction as against other forms of discrimination.

2. Future of Work and Technology

The landscape of work and jobs changed dramatically in 2020. The envisioning of the future of work in bringing about a sea change in the labor market no longer seems unlikely. In the 2019 survey, about 73 percent of the executives predict significant industry

disruption in the next three years due to technological changes and other factors, up from 26% in 2018 (Mercer, 2019). One in five jobs will be replaced by artificial intelligence and automation and 42 percent of core skills required to perform existing jobs will change in the next two years (World Economic Forum, 2020). The impact is visible across a wide array of sectors. Robots and automated machinery are disrupting the jobs in production industry as much as advanced software and artificial intelligence is replacing the white-collar occupations in sales, accounting, trading and logistics (Acemoglu and Restrepo, 2018).

The emergence of the so-called ‘techno-axial age’ (Bessant and Watts, 2021) has made the analytical and novel cognitive technologies as the most important skill for a human worker. The massive retraining and reskilling of the workforce is touted as the way forward. However, it is possible that the pace of reskilling might not be as fast as the changes in technology. The relentless pace at which automation is taking place, societies will no longer have the ability to foretell reliably the skills that will be needed in future decades (Harbert, 2020). With the constant evolution of technology, the future of work has become devoid of meaning and certainty. The digital economy has a negative impact on the labor market in terms of increasing a sense of insecurity and isolation for existing workers. The state of flux and anxiety ushered in by the increased dependence on tech power has given rise to a global debate about how far it will be possible to gainfully employ all workers. The world of work has realized that for organizations to fully benefit from technology, they must support the development of a workforce with digital skills. Capitalism is being replaced by ‘talentism’ (Carlson, 2021). Younger workers seem to be getting all the leverage in this. According to the director of Malaysian Employers Federation,

“The younger generation has an advantage, especially those who are more agile, flexible and IT-savvy compared with older workers. They are generally digitally savvy and can accept new forms of employment such as the gig economy and e-commerce platforms.” (Kwan, 2020)

Although automation induced worker displacement affects workers in all age groups, it is the older adults who would move to less automated and low wage domains or even choose to exit the labor force entirely

(Groschen and Holzer, 2019). A study in the U.S by Wanberg et al. (2016) found that the tendency to remain unemployment after redundancy is 10.6 weeks longer for those aged 50 or above as compared to those between 20 and 29 years of age. The older workers also constituted 48 percent of the category of workers at risk of displacement by automation in Singapore (Lee, 2017). With the onset of the pandemic and the concomitant shifting of work from office to home has increased the reliance on tech usage abilities. Consequently, the workers in the older age group have been the worst affected. In Malaysia, almost 18,397 workers aged 45 and above lost their jobs and are now less likely to find employment in the weak labor market following the Covid-19 pandemic (Kwan, 2020).

1. Challenges in the age of technology for Older Workers Naturalistic Age Induced Changes

There are certain age-related issues such as difficulty with corporal deftness and agility; reduced cognitive functions; impaired vision and problems in performing activities of daily living (ADLs) (Czaja and Lee, 2003). Particularly, technology usage requires a good level of cognitive functioning and research shows that there is a cognitive impairment with age (Administration on Ageing, 1996). Cognitive aging causes mental functionality to become less dexterous and flexible with some facets of memory function getting affected. As a consequence, older people find it hard to concentrate in busy environments and get distracted easily which also leads to more time and efforts on their part to work their way through complicated problems and decisions (Institute of Medicine, 2015).

The Economic Risk Perception

A higher proportion of older workers is often correlated with a lower productivity in terms of output per capita. Prskawetz et al. (2008) reports that as the working age population declines, the support ratio changes and this increases the proportion of consumers to producers. This has a direct negative effect on output per capita. The hiring of older workers also carries the biggest risk of a substantial rise in healthcare expenses. The prevalence of chronic illness becomes much more common and in turn affects the sustainable employment projections for both employers and employees.

The Concern for Younger Employees

The age bias in recruitment and promotion policy of most enterprises stems also from a concern for the career growth of the younger workers. Kulik et al. (2014) have found that strategies to retain or retrain older workers may block the promotion and advancement prospects of the younger workers. The delays in promotion of the younger workers may deprive them of the experience to make the transition towards leadership positions. The changes in retirement and reemployment structures in favor of the older workers can thus prove challenging in terms of keeping the younger workers engaged and motivated.

The Complex Nature of Technology

There is a widespread feeling of uneasiness amongst the elderly groups that stems from the perceived complex features of technology and its usage. These characteristics of technology can range from the small prints, keyboard patterns, system designs to the online or tech jargon and the changes in modes and patterns of tech usage. Malenhorst et al. (2001) have found that the most common argument advanced by older adults with regard to new technology is that some types of technologies do not work easily. Furthermore, technologies keep evolving and the standard studies on the know-how of their working can take some time to be deciphered, understood and disseminated.

Existence of a Disinclined Attitude

Due to failed experiences, older adults fathom technology as a risky alternative to traditional modes. They consider technology is costly, confusing and complicated to use and thus do not feel inclined enough to take advantage of the benefits that technology can offer. Some simply reject online tools as they consider them too arduous and time consuming. In a study by Lancaster University, more than the accessibility issue, it was the personal fear over making mistakes and disdain over the suitability of online tools that drove older people away from an extensive use of technology in day to day life. In an interesting finding, older people want to hold on to the traditional face to face or offline interactions between people to prevent the loss of jobs and social isolation that can ensue with online and automated mode of work (Knowles and Hansen, 2018).

Perceived Difficulty in Learning

According to Marquie et al. (2002), learning about new technologies is challenging for all but the elderly population usually views this learning process as a giant task or too difficult to be grasped well without a base in ICT knowledge. This basic attitude leads to a very low confidence in their self-potential or ability to learn about or to operate technology (Eastman and Iyer, 2004).

Issues Related to Training and Assistance Support

Older workers face a number of hurdles in a meaningful participation in skill development programs. Irizarry et al. (2002) have found in their study that although training programs on tech usage abound, they do not specifically cater to the pace at which people in older age groups can understand. A mere provisioning of learning and training for all age groups is not enough, it has to be tailored to the specific needs of the geriatric workers. According to Osman et al. (2005), there is a lack of sensitive and caring training professionals who can make the learning process worthwhile for the elderly. In some cases, there is not enough training or assistance support within reach or budget.

Lack of Information and Locational Disadvantage

Technology has again induced a barrier in terms of the information about the options available for the experienced and skilled workers for those who have not yet embraced new modes of working. Online recruitment has become a norm everywhere and the use of social media and other professional platforms or job searching engines require a minimum online workability. Older workers trying to find flexible work opportunities suffer from the geographical mismatch between the needs of the labor force and demands of the labor market. Places where skilled workers are in high demand face skilled labor shortages and places where skilled labor is available have very few work opportunities.

Employer Attitudes

Most employers have a deep skepticism about the returns that any investment in older workers will reap. Most commonly held perception relates to the retirement intentions of the older workers and how far any training or reskilling can be beneficial for the organization. A study by Ferrier et al. (2008) explored the views of managers about the productivity of older workers and the findings revealed that most managers perceive the return on investment in reskilling to decline with age.

The consensual view appeared to hold the contention that it was more prudent and frugal to teach new technologies to younger employees than their older coworkers (Ranzijn 2004). According to Chappell et al. (2003), older workers are often the most vulnerable targets whenever any disruptive changes take place in the modes of working and the compliance of employers with the age related anti-discrimination laws is highly uneven. Peter Cappelli, Professor of Management at Wharton School of the University of Pennsylvania, makes a strong argument in stating that it is a myth that older workers lack in their ability to work around new technology or are too slow for the fast paced work. The real issue is that younger supervisors do not want to hire older workers as they are afraid and do not know how to manage these older workers. Thus the basis of discrimination is a sense of insecurity and lack of sensitivity or prior experience in dealing with the older workers.

The Cost of Accessibility

A subscribed access to the internet is indispensable for working with technology and the cost is not affordable for many older adults in the lower income bracket. According to one estimate, out of 70 nations only 44 nations had the cost of monthly DSL (digital subscriber line or the high-speed internet) access within the considered affordable point of 2.5 percent or less in the median household income (The Economist, 2008). Research from the Alliance for Affordable Internet and the Web Foundation reveals that low and middle income countries are finding the mobile phones too expensive and this is keeping many offline. The survey found that as many as 2.5 billion people reside in nations where the price of the lowest range available smartphone is at least a quarter of the average monthly income. This amounts to the spending of an average European household on housing and utilities (Woodhouse, 2020). Needless to say, older people are an important marginalized section in low income nations and have to struggle more for getting access to IT enabled products and services due to affordability issues.

Lack of Suitable and Flexible work

Some companies are losing experienced talent because there is little appetite to offer flexible working conditions. Employees who have worked in the organization for a long time are the most loyal and know exactly the most efficient way of getting the work done

through their long-standing networks and web of relationships. After a certain age, most employees are looking for a flexible work hours to allow a good balance between work and non-work activities (Griffin and Beddie, 2011). In terms of the type of work, older people want work that is not as demanding or target-filled but one that utilizes their know-how and expertise in meeting the larger goals of the company. This typically translates as opportunities for mentoring and coaching the young talent. Unfortunately, employers are not able to provide this flexibility in terms of time and choice of work and end up losing the good talent. Dalen et al. (2009) compared the attitudes and actions of employers in their handling of older employees in the European Employers Attitudes Survey 2005 conducted in four European countries — Netherlands, Greece, Spain, and the United Kingdom. They found that —“The majority of employers anticipate future problems due to a shrinking workforce, and the ageing population is one of the core drivers of this. However, only a minority of employers implement or consider implementing measures aimed at retaining personnel, in terms of easing the leisure—work trade-off, reducing stress at work, adjusting tasks and capabilities, and adjusting working conditions”.

3. The Way Forward: Options

Forward Looking Employers

Policy changes such as extending retirement age limit can provide motivation for older workers to remain in the labor force. However, this does not necessarily translate into enough motivation for the employers to hire older workers. The world needs forward looking employers. Employers have a role to play in propagating a fluid interpretation of retirement in the society. With the help of far-sighted employers, occupational changes, mini-retirements and sabbaticals and a non-linear career trajectory can become the new normal and help immensely in fighting the rampant societal ageism apart from curtailing labor shortages. Moreover, the effect of social portrayal in engagement of older workers at the workplace can be significantly dealt with by organizational changes. For example, some challenging and techno-driven tasks can be allocated to older employees to boost their confidence and also to change the age-related stereotypes about age and work performance among the age-diverse workforce.

In the study by American Enterprise Institute, Orrell, et al. (2020) outline that the roadmap to workforce recovery calls for employers to establish 'Personal Reemployment Accounts' for each employee wherein the worker gets to select a training that fits best with individual need, level and interest. Employers who are looking at the long-term sustainability of labor and workflow can invest in the formation of reemployment departments or centres within the organization that can allow workers facing multiple barriers to return to work quickly and smoothly. Employers and businesses can benefit from the increased use and ease of technology by creating a real-time, easy-to-access and comprehensive labor market information system that can enable employers to nurture and develop the talent and skills that are currently in demand or will be needed in the futuristic world of work.

Retention Adjustments in Labor Policy

The Japanese government has implemented various employment policies, to actualize "a society where people can work until 70 years of age." The policymakers aim has been to encourage employment of older population; sustain and enable re-employment of middle-aged and older people willing to work; and accelerating assistance in making diverse work opportunities and social participation of older adults a normal feature of Japanese society (Japan Organization for Employment for the Elderly and Persons with Disabilities, 2006). Countries in Europe have also initiated phased retirement and post-retirement work programs to leverage worker expertise and commitment

Active ageing

A significant development in the discourse on the policy issue of ageing society is the Active Ageing Policy Framework. The concept being promoted is "Active Ageing" i.e. the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age (WHO, 2002). The framework is a vision that intends to deal with world ageing through positive policy interventions and calls upon the policymakers to spring into action. The concept has created a blueprint for devising multi-dimensional and multi-sectorial policies catering to active ageing with an aim to improve wellbeing and involvement among elderly populaces while safeguarding that older people have sufficient security,

support and care when they need assistance (Andrews, 2001).

Multi-Generational Workplace

As the new demographics play out in the world of work, the five generation workforce is already becoming a reality. A multigenerational workforce comprises a workforce with diverse age groups with employees belonging to different generations such as the baby boomer generation, Generation X, the millennial generation, and Generation Z. Organizations thus need to prepare themselves to manage a multigenerational team with changing requirements, standards, and concerns (Fica, 2019). From technophobic to tech savvy and tech native, the employees are bound to have vast differences in their abilities and perceptions of new technologies. Thus organizations need to cater to the need of each age group in making them up-to-date with the new innovations at work.

Technology Based Training

The most important policy change that can redress the problem of lack of tech skills is a holistic yet dynamic and flexible training model for the specific pace and needs of the geriatric workers. Lee et al. (2009) in their research have found that workers express a desire to receive additional training on technology and display a preference for classroom training. A self-paced training by sensitive and caring professionals can effectively meet the needs of the elderly workers in adapting to new technological shifts at workplace and to integrate technology in their day to day life. The literature on skill acquisition reveals that although older workers may take longer and more practice and environmental support, they are able to learn new skills just as anybody else (Charness and Czaja, 2005).

Flexible Working Practices

Flexibility matters and it matters the most when employees have spent a lifetime working for the organization or in a particular domain of work. It is important to be mindful of the heterogeneity of the population in the older age cohort. Loretto et al. (2009) have pointed out that workers in later years of their lives differ vastly in terms of skills, education, work pattern and history, health, geographical location, gender and family circumstances. To cater to the varying needs and privations of this group and to keep them motivated, the

working arrangements need to be generously flexible. This entails bringing about policy changes for both temporal and functional flexibility in work. Flexible working arrangements (FWAs) for older workers have been implemented in firms in United Kingdom to promote 'more sustainable working lives' (Atkinson and Sandiford, 2016). These practices and arrangements can work out well in retention of skilled and highly talented and experienced workforce.

Aging not Existential but Contingent

A very subjective but significant dimension related to perceptions surrounding ageing is the difference between contingent and existential limitations. Baars et al. (2006) underscores the need to recognize that age-induced senescence like lack of adequate care, societal social seclusion, undernourishment or poor housing and sanitation conditions. Quite often these limitations result from insufficient information, negative fallouts of some policies or just caused by a disinterest or lack of concern for the welfare and well-being of the elderly. On one hand, an existential perspective will view all limitations as given and part of senescing wherein the older people can only accept all circumstances even if they are awful. On the other hand, a non-existential perspective will adopt a contingent view of the limitations suffered by the elderly and lead to the development of a positive attitude wherein one does not have to accept the circumstances but understand that if proper time, resources and willpower to change is there, then all sorts of problems can be solved (Grey, 2005).

Building an Age Diverse Talent pool

With regard to the retention of talent and reduction in attrition rate, the companies can find a middle ground between keeping a certain level of turnover and also addressing the shrinking workforce. Employers realize that experience and tenure is important. It is time now to act on the building of talent pool and models that focus on critical jobs with a 'ready to work now' cohort and creating pipelines of skilled labor supply by making it age diverse. This also requires redefining the definition of what is the right talent and stripping it of its age and other stereotypes. When the right kind of pipelines exist in the workforce, finding the right person with the right skills for the right person becomes smooth with the added advantage of atrophying ageism in the world of work.

4. Conclusion

This paper looked at how innovation and technology can redefine the future of work and how this can impact the ageing workforce. In envisioning the future of work, there is a need to also focus on the purposeful and inclusive aspects of work – employee well-being and employee engagement that keeps in mind the role and resourcefulness of employees of all age groups. The study calls for demystifying the presumptions that make older workers stay away from exploring their full potential and to learn the new technological know-how. With concerted efforts, the challenges being faced by the workers in later years due to the shifts in new technology-induced work patterns can be offset and the looming crisis of shrinking workforce can be resolved.

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