An Intelligent Approach for Improving the Effectiveness of Smart Computing

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ABSTRACT
Devices can communicate and share information in a smart environment using new generation technology. Smart computing, next-generation computing, is a combination of hardware, software, and network to provide real-time awareness of real-time systems. It aims to monitor, analyzing, and reporting in a faster and smarter way to make a system, as a smart system. This study follows the identification of the various factors that may affect the effectiveness of smart computing. As a result, some factors were identified hypothetically using a comprehensive literature review approach. After performing the analysis, the most important factors were identified. Then, an intelligent approach is applied for improving the effectiveness of smart computing. Lastly, the conclusion concludes along with the future scope which summarizes the work.

Keywords
Smart Computing, factors, CLS model, relationship model

1. INTRODUCTION
Today, a world is full of smart technology working in a smart environment with smart devices where each device can connect, communicate, and transfer information to one another[21].Computers are performing a more secure and faster computation. Examples of such smart environments consuming smart technologies are Smart-watches, smart-phones smart-homes, smart-cities, smart agriculture, and so on. In this paper firstly, an introduction of smart computing is covered. The next step is the identification of affecting factors for the effectiveness of smart computing. The objective is for identifying and reviewing all the factors that affect the 5 A's of smart computing. Also, the most important factors identified among them. This is done by identifying the factors hypothetically based on the model. Next, is about an improvement in the effectiveness of smart computing. The objective is to improve its effectiveness. This is done by predicting a dependent factor using independent factors using classification (categorical value prediction) and application of linear regression techniques.

Lastly, the work concludes by suggesting an intelligent approach to identify the factors and how they affect the effectiveness of smart computing along with the future scope.

2. SMART COMPUTING
Smart Computing is a combination of two words: Smart and Computing, where SMART means Self-Monitoring, Analyzing, and Reporting Technology. And Computing means performing computational analysis. Therefore, it collects and stores the data, monitors, and detects for what purpose it was designed, analyzes it, and report in advance accordingly to the user.

According to researchers, SMART refers to Specific Measurable / Measurement Achievable Relevant Time-Oriented and computing to perform calculations quickly. Monitoring, analyzing, and reporting in a faster and smarter way to make a system, as a smart system. The main focus of smart computing is to provide cheaper technology, solving an existing problem, and look ahead to future problems and preempt them before happening. It is a sensor-based technology, with the combination of the Internet of things (IoT), machine learning, Big Data, Artificial Intelligence, etc.

2.1 Background
Not since today but from the era's, computer technologies are working on its tools and techniques to make our daily lives more simple and easier[26]. Today every object is connected and communicates with each other in an environment. These objects are hardware and software devices we use in our daily lives that communicate using the internet to share their data and current status over the internet[10][20].

The technology through which the hardware and software devices communicate with each other using the internet and share information is known as **SMART COMPUTING**[5][9][20][26]. It is the next generation of computing that is used to create something self-aware that is it can sense the activities of its environment, massages the gathered information, perform some analytics, and provides the optimal decisions along with predicting future risks and challenges. In this, the communication process takes place among devices through

- Sensors
- Development boards-Arduino, Raspberry-Pi
- Cloud

Sensors may be hardware or software components that sense the physical world and share the information with the development boards. This development board processes the data with the help of controllers and processors and triggers a task. And the cloud securely stores the shared information with the help of the network and transmits back when required[2]. To store the information on the cloud and for the communication process, a communicating language such as python, C, or Java and communicating protocols such as HTTP, MQTT, WebSockets are used. To make the process more secure, only the authorized person is allowed to access the data.

2.2 Components of smart computing
The components explain how the information travels in this technology and how smart computing functions. These are as follows:

- Sensors devices for sensing the data from hardware and software devices
- Device processors for processing and learning with the previous data

- Cloud for storing the information
- Communicating protocols such as HTTPs or MQTT
- Communicating language such as python

In smart computing, there is 70% of the hardware utilization that is more use of resources with the smart OS. Smart OS makes computation faster, efficient, and smarter.

2.3 5 A's of smart computing

Smart computing comprises five key functions which are 5 A's of smart computing[5][10][26] that is discussed below:

a. Awareness
b. Analysis
c. Alternative
d. Action
e. Auditability

All the functionality of smart computing evolves around these 5 A's and analyzing, reporting and monitoring functions are performed accordingly. The detailed discussion of the 5 A's are discussed below in Table1:

Awareness is the most important A among all the 5 A's of smart computing. **Innovations in Awareness will have the most revolutionary impact**, the statement justifies as if there is a lack of awareness, then the analytical tool detects and stores the wrong information. An alternative triggers the wrong action that makes a wrong decision regarding which may lead to a serious problem in the future.

Table 1. Description of 5 A's of smart computing

S.No	5 A's	Description
A	Awareness	• Identification of tools and devices, use of sensors, GPS, RFID[22] • Identification of customers(a type of user, identity, location, status)[5][26][28] • Identification of integrated communication technology such as 3G, 4G, etc.[5]
B	Analysis	• Easy and adaptable servers • Storage device enabled by server visualization • Data-center automation • Storage life cycle management • Stretchy processing expansion • Increased storage capacity
C	Alternatives	• Identify rule engines and workflow[31] • What decision should trigger at necessary actions
D	Action	• Correct action occurs at the correct time • On-time notification • Type of process application (action will execute through integrated links to application)[10]
E	Auditability	• Technology needs to capture, track and analyze information • What actions are taken(right or wrong) • How to improve analysis • Identify better alternatives[5][10].

For example, the train tracking system tracks and navigate the exact position of the train. This tracking system provides information about the free track for the trains. If there is any train on one track train has to divert to the next track to prevent the accident. However, if there is a lack of awareness, the system transmits wrong information about the track and predicts there is no obstacle on the path. This wrong information is passed further for analytics and the data about the blank track which is not blank is stored and accordingly, the wrong action is taken which may lead to long waiting or take a wrong path or may lead to an accident. Hence, proper awareness and improved analytical tools to be used to avoid such problems. There must be proper fine-tuning among 5A's of smart computing[5].

3. REVIEW RELATED TO SMART COMPUTING

In Forrester's white paper report, Andrew H. Bartels [5] gives a basic idea of smart computing along with its 5 A's that are its key functions and discusses how can help in driving the new era of IT growth. This report explains the evolutions in the generation of computing. The main focus is to explain how smart computing helps in predicting future business risks and the growth of the market in the field of technology.

Mrs. Monika Garg, Mr.Promod Kumar, Miss Swati Aggrawal[27] explains how green computing is smart computing. The idea behind is energy efficient energy and eco-friendly computing. Effective coding is to conserve resources to make less use of the hardware by having the program.

Matthew N. O. Sadiku, Yu Zhou, and Sarhan M. Musa [26] provide a detailed review of the introduction of smart computing and its application areas.

Muntasser A.Wahsh and Jaspaljeet Singh Dhillion [25] reviews the factors that affect the adoption of cloud computing for e-government and public sectors. This study follows a systematic literature review (SLR) approach that helps to identify what are the various factors that affect cloud computing. As a result, Fifty-nine factors were identified based on their frequencies and seven among them appear to be most important.

Apurva Adapa, RichardH.Hall, Samuel N.Smith, Fiona Fui-Hoon Nah, and Keng Siau [6] explores the contributing factors and their relationships that influence the adoption of wearable devices through in-depth interviews using a ladder approach. This research also provides information about using the laddering approach to data collection and analysis.

Luis AugustoSilva, Valderi Reis Quietinho Leithardt, Carlos O Rolim, Gabriel Villarrubia Gonzalez, Claudio F.R.Geyer, and Jorge Sa Silva [11] develops an alert and a notification management system. The study discussed how the number of users and devices is increasing daily and their tolerance may decrease in a short time. Hence there is a need to develop a system.

Adela Jukan, Xavi Masip-Bruin, and Nina Amla [2] discusses

applications of smart computing. It provides the application of smart computing sensing technologies for domestic, farm, and wild animal welfare.

Tae-Gyu Lee, Seong-Hoon Lee, and Gi-Soo Chung [23] discusses the structural and functional issues of smart computing and how smart computing interact with cloud computing for contributing accessible information. Two proposed work: Smart table and Smart control algorithm. Robert E.Kahn [29] highlights the generations of computing. The study provides a comparative study of five generations of computers and computing technologies based on computer hardware, computer software, telecommunication technologies, and computer performance. What qualities do an intelligent system must possess and advancements in different fields of computing technologies are also considered.

4. THE IDENTIFICATION OF AFFECTING FACTORS FOR THE EFFECTIVENESS OF SMART COMPUTING

The key factors of smart computing and are closely connected and dependent on one another. At very first, the awareness is performed which means to get aware of what could happen next by collecting real-point data with the help of sensors, RFIDs, or any devices that capture the information of the customers, or identify the location, or check the current status[20]. This awareness is dependent on some analysis, which is done using some business intelligence and analytical tools to check whether this alert is important or can be ignored. Thirdly, identify the alternative action that can be done in response to anomaly using the rule engines and workflow. And accordingly, actions are performed. Lastly, capturing and analyzing the data on activity at every stage for future problems and improvements using auditability. All the 5 A's, anyhow, may depend on some factors which affect them. Factors of smart computing are identified hypothetically by the following questions

- Which factors influence the 5 A's of smart computing?
- Which factors are more important?
- How these factors do affect the adoption of smart computing?
- What are the different challenges associated with the affecting factors?

To answer these questions, a CLS model (Comprehensive Literature Survey) is designed. This shows how previous work is beneficial in this work to identified factors based on the survey.

The following factors are identified that are associated with smart computing using the CLS MODEL.

Adaptability[1][25], Verification[2][28], Authentication[28], Authorization[28], Accessibility[2], Availability[22], Security[2], Autonomy, Flexibility, Adaptability, Reliability, Manageability, Predictability,

Fault-tolerance, Failure management, Accuracy, Maintainability, Transparency, Robustness, Reusability and so on. Among the numerous factors, Accuracy is the most important factor.

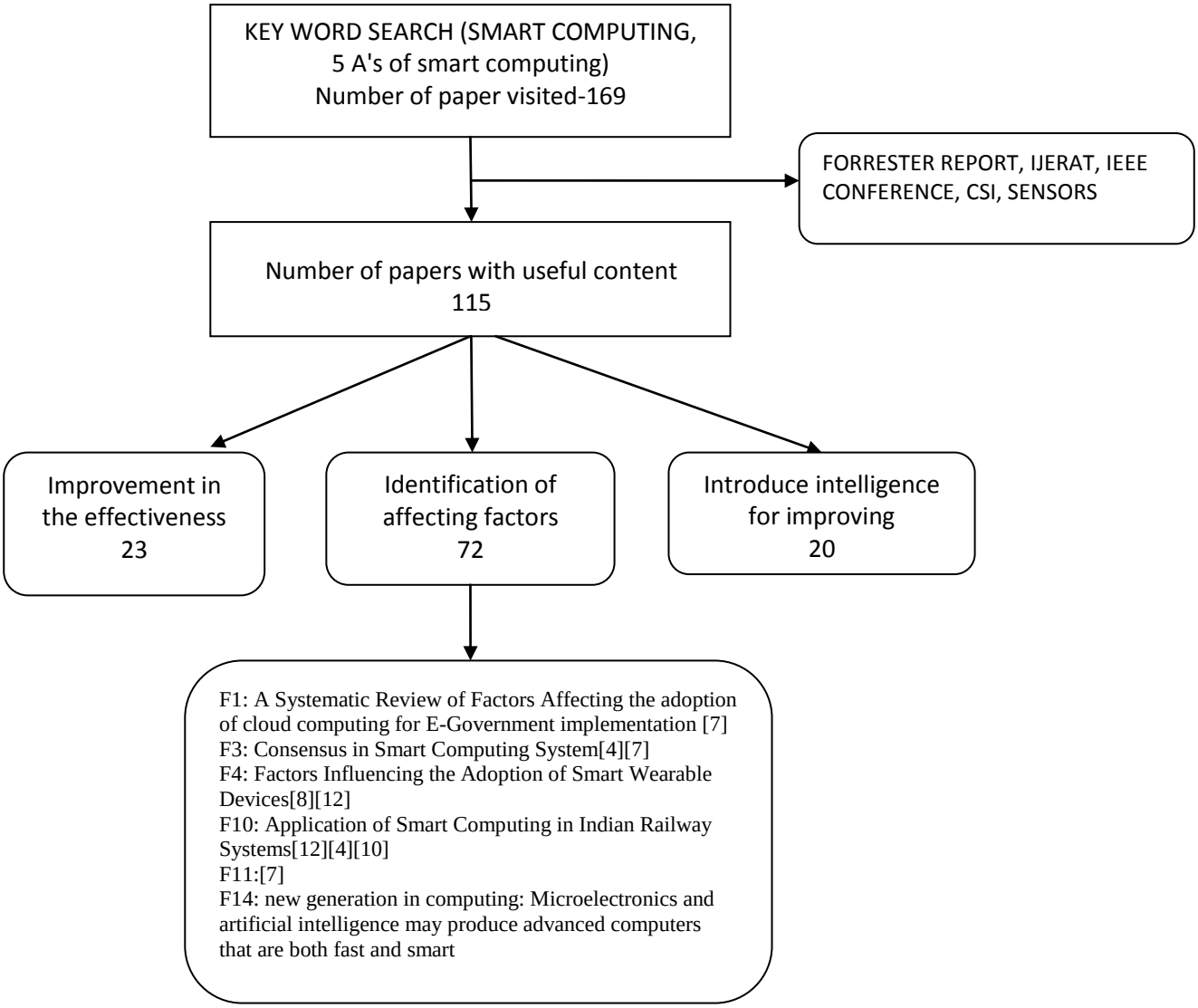


Figure-1: CLS MODEL

5. RELATIONSHIP BETWEEN A's AND AFFECTING FACTORS

The following figure 2 represents the relation of the factors in 5 A's of smart computing. Some of the factors are reflected in more than one A's of computing. F represents the factors and A represents the 5 A's of smart computing.

- Indication of factors (Adoptability, verification, security, authentication, authorization, accessibility, availability, autonomy) mapped to Awareness (A1).
- Indication of factors (flexibility, adaptability, reliability) mapped to Analysis(A2).
- Indication of factors (manageability, availability, predictability, autonomy) mapped to Alternatives (A3).
- Indication of factors (fault tolerance, failure management, accuracy, maintainability, reliability, transparency, robustness) mapped to Actions (A4).
- Indication of factors(failure management, accessibility, reusability, accuracy, maintainability, robustness) mapped to Auditability (A5).

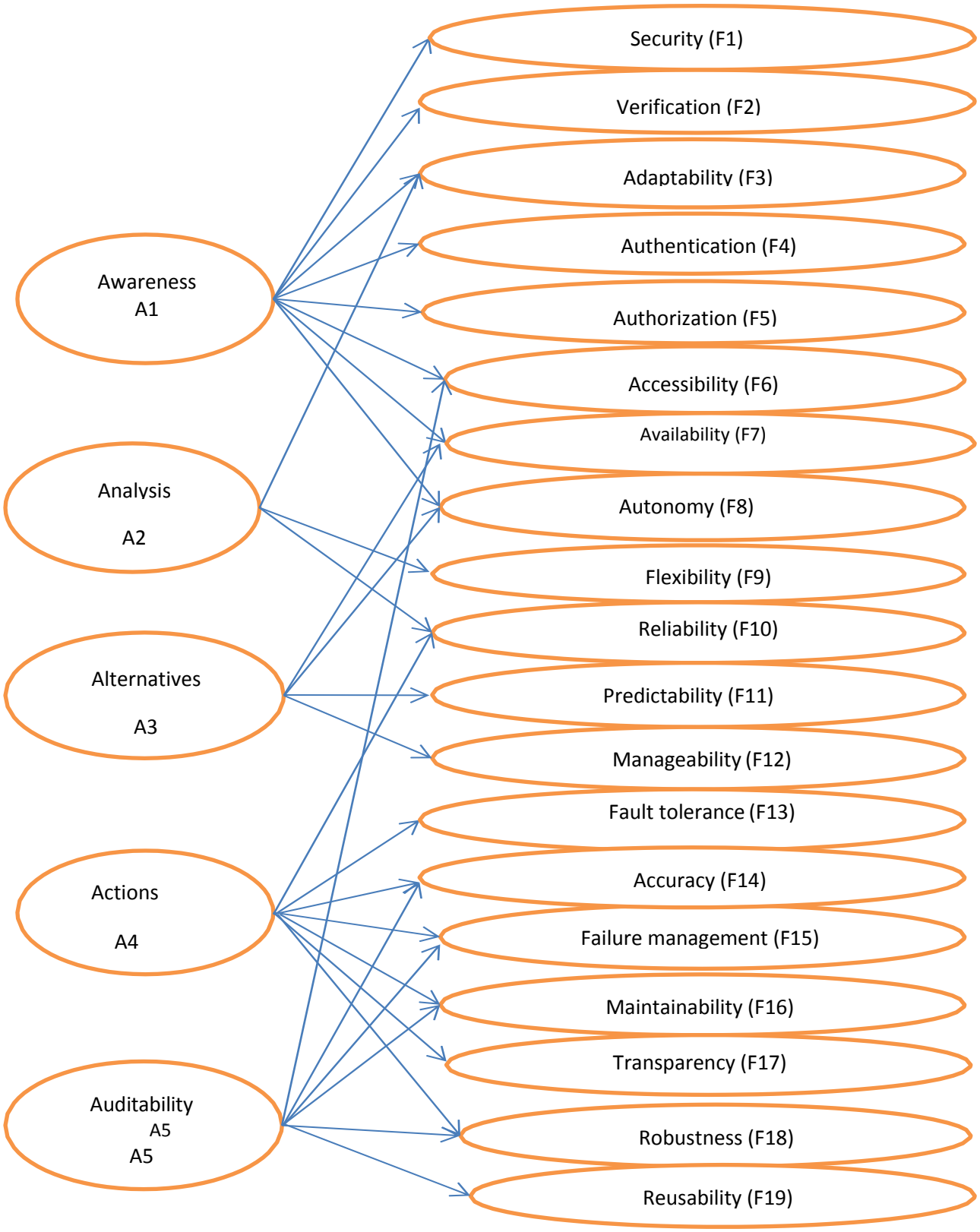
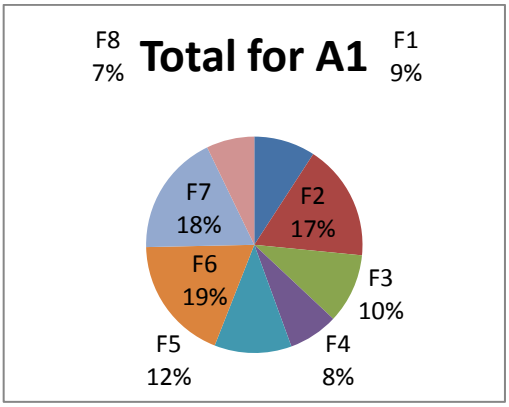


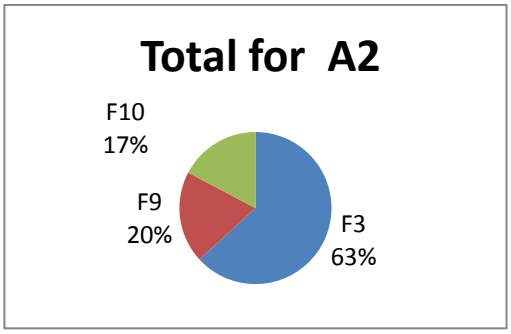
Fig 1:Relationship between factors and 5 A's

6. A TECHNIQUE TO INTRODUCE INTELLIGENCY FOR IMPROVING THE EFFECTIVENESS OF SMART COMPUTING

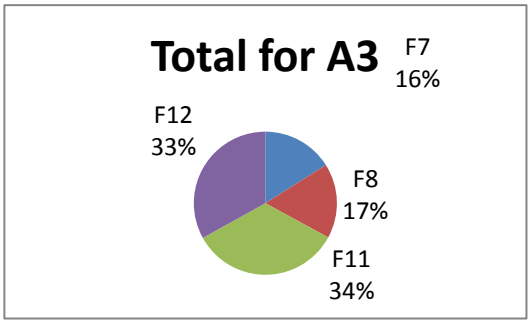
Use of statistics to identify the relationship between the variables. This includes introducing intelligence for improving the effectiveness of smart computing correlation and regression model for identifying the factors and 5A's relationship.



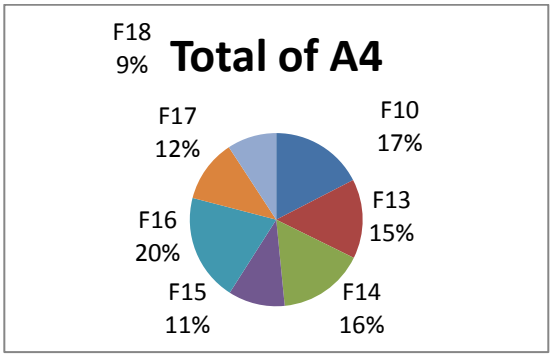
The pie-chart represents the percentage of factors against A1. The diagram shows the contribution of factors for the formation of A1.Therefore,F1 contributes 9%,F2 contributes 17%,F3 contributes 10%,F4 contributes 8%,F5 contributes 12%, F6 contributes 19%, F7 contributes 18% and F8 contributes 18% for the formation of A1.



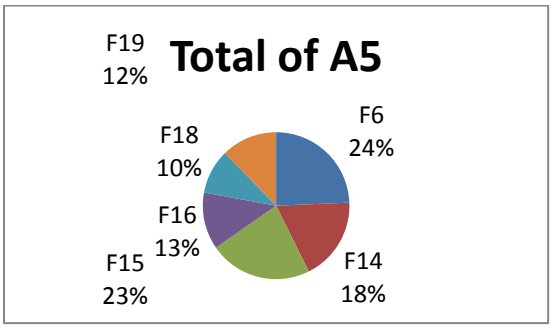
The above pie-chart represents the percentage of factors against A2. The diagram shows the contribution of factors for the formation of A2.Therefore,F3 contributes 63%,F9 contributes 20%, and F10 contributes 17%.



The pie-chart represents the percentage of factors against A3. The diagram shows the contribution of factors for the formation of A3.Therefore, F7 contributes 16%, F8 contributes 17%,F11 contributes 34%, and F12 contributes 33%.



The above pie-chart represents the percentage of factors against A4. The diagram shows the contribution of factors for the formation of A4.Therefore, F10 contributes 17%, F13 contributes 15%, F14 contributes 16%, F15 contributes 11% , F16 contributes 20%, F17 contributes 12% and F18 contributes 8% .



The above pie-chart represents the percentage of factors against A5. The diagram shows the contribution of factors for the formation of A5.Therefore, F6 contributes 24%,F14 contributes 18%, F15 contributes 23% , F16 contributes 13%, F17 contributes 12% ,F18 contributes 8% and F19 contributes 12%.

7. CONCLUSION

With the comprehensive and systematic literature survey of previous work, the factors that may affect the effectiveness of smart computing are identified. Hence, overall the work is dedicated to "The identification of affecting factors for the effectiveness of smart computing".There is also a need to analyze how these factors may affect the effectiveness of smart computing. A various literature survey was performed to identify the analyzing techniques used for smart computing. Hence, overall the work is dedicated to "An improvement in the effectiveness of smart computing".Various approaches can be used so that they can improve the effectiveness of smart computing. Hence, overall the work is dedicated to "Introduce intelligence for improving the effectiveness of smart computing".

After providing the method that improves the effectiveness of smart computing by applying an intelligent approach, the overall work is dedicated to" An Intelligent Approach for Improving the Effectiveness of Smart computing".

8. FUTURE SCOPE

The future scope of the work is that various other factors other than these 19 factors can be identified that can affect the effectiveness of smart computing.

The quantitative data which has been used for the analysis can have a varied and the observation can be carried with a

different set of values.

Other attributes that can affect the factors can be identified that can directly or indirectly affect the effectiveness of smart computing.

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