
Investigation on the Impact of Leadership Styles Using Data Mining Techniques

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<http://dx.doi.org/10.5772/intechopen.78660>

Abstract

This chapter focuses on the three major leadership styles, namely, laissez faire, transactional and transformational leadership styles and their relationship to the leadership outcomes (extra effort, effectiveness, and satisfaction). A review is conducted on related leadership theories, development of leadership styles and the relationship between leadership styles and the outcomes. The survey using convenient sampling method was carried out in the Bay of Plenty Region of New Zealand. A quantitative analysis was conducted on collected data using statistical methods (such as correlation and regression analysis) and state-of-the-art data mining techniques (rule-based approaches and decision tree modelling) were also used to ascertain the relationship between leadership styles and leadership outcome. The data mining techniques were used to extract hidden trends and patterns in the data to report various ways to increase the employee outcomes by fine-tuning leadership styles. The results of such research would enable the small- and medium-sized enterprises (SMEs) to identify the most prevalent leadership styles and to devise actionable strategies to improve the best suitable leadership styles for the management.

Keywords: leadership styles, management, data mining, rule-based algorithms, decision tree algorithm

1. Introduction

Trade has been an integral part of human evolution. Trade started when humans began to live in social groups and gave up isolation. This culture of community gave birth to the idea of exchange of goods and services to fulfil human needs later known as business. It is an

economic system in which goods, either manufactured or procured, are exchanged for hard currency. Present day, services are also considered as businesses and are also exchanged for money. With the growth of human society, business activities and processes become complex; hence, the management of business activities became the focus of attention. There was a need for effective managers who can handle daily and periodic business transactions and can make good and timely business decisions. Many management theories are developed and implemented to help improve organisational productivity and services. Some of the most commonly practiced theories are contingency theory, chaos theory, systems theory, leadership theory, theory X and theory Y [1]. All these theories address various aspects of organisations and help management devise strategies to increase productivity. With the increase of competition and global market, businesses were required to make timely and effective decision. This requires the role of managers to be evolved as leaders. Good managers are essential for running organisations, whereas leaders are required to make organisations successful.

In contemporary business environment, leadership has become an important component in organisational sustainability. Leadership is a process by which one person influences the thoughts, attitudes and behaviours of others [2]. Organisations have unique personalities and mostly evolved around the personalities of their leaders. Conventionally, it was believed that land, labour, capital and entrepreneurship are four main factors which are integral for an organisation. In today's economy, leadership acts as a catalyst that makes all these factors work together to achieve organisational goals.

In the literature, various leadership styles are proposed. However, most of these styles converged to one of the five different leadership styles, which are autocratic, laissez faire, participative, transformational and transactional leadership styles [3]. These leadership styles are not mutually exclusive and have certain degree of overlapping.

Autocratic leadership style is also known as authoritarian leadership style. In this leadership style, a single individual possesses control over the decision-making and others have minimum input in those decisions. Autocratic leaders seldom take advice from other and make decision based on their ideas and judgements. In laissez faire or delegative leadership style, leaders seldom make decisions instead let employees to make most of the decisions. Most of the decision-making power lies with employees and very little or no guidance comes from the leaders. This leadership style can only work if employees are high competent and no supervision is required. Participative leadership style is also known as democratic leadership style. In this style, employees are provided with pertinent information on the issues and challenges faced by the organisation and engaged them into the decision-making process. The main drawback of this style is that the decision-making process is slow, but at the same time the benefit is that employees do contribute in problem-solving process and improve employees' commitment to the organisation. Transactional leadership style has its basis in controlling, organising and short-term planning. In this leadership style, employees are motivated by appealing to their own self-interests (in the form of rewards and punishments). Employees are rewarded if they perform well and punished for not doing well on their assigned tasks. Finally, in transformational leadership style, leaders are regarded as visionary, inspiring and thoughtful thinkers. These leaders must exhibit inspirational motivation, intellectual

stimulation, idealised influence and individualised consideration. This style of leaders spend a considerable amount of time to mentor their subordinates [3]. To measure the leadership outcome, the following three measures are used in the literature.

- Extra effort, is the measure of willingness of employees to exert extra effort to accomplish tasks.
- Effectiveness, is the degree of leaders' effectiveness in the eyes of the employees.
- Satisfaction, is the employees' level of satisfaction on the leaders' capabilities.

A number of studies have been conducted on the impact of various leadership styles on employees' outcomes [4–7]. These studies have used statistical analysis such as correlation and regression analysis to investigate the underpinning relationship between these dependent and independent variables. The correlation coefficient can describe the relationship between any two variables, and regression analysis scrutinises the relationship of multiple independent variables on a dependent variable. These techniques do not explain why these dependencies exist or provide a higher level logic description of these dependencies. The aim of this research is to fill this gap by employing data mining techniques and demonstrating that the use of these techniques can enhance our understanding of the data.

The data mining term is used to describe searching through the databases to find interesting and previously unknown patterns. Now-a-days with the revolution of digitization and abundance of data, the field of data mining has become an important component of organisations. The field of data mining provides tools and techniques to automatically process large volume of data and extract useful information which can used to make strategic decision in organisations. Most of the data mining techniques are based on inductive learning [8]. The inductive learning involves detecting interesting patterns and building appropriate model based on processing reasonable amount of training examples.

In recent years, the use of data mining techniques is becoming popular in the retail industry, stock market, telecommunication and customer relationship management [9–12]. Internet providing companies are using optimisation algorithms to manage the search and data retrieval traffic on the internet to avoid data congestion. Moreover, companies are using similar approaches to faster deliver customers' goods to their doorstep by incorporating intelligent data analysis techniques to avoid road traffic congestion. Now retail companies have been able to provide better services based on analysing customer buying behaviours (i.e. market segmentation, market basket analysis and seasonal data analysis) [11, 13–16].

The data mining techniques can mainly be divided into classification and clustering. In classification, data consist of input attributes and output attribute (class labels). The task of any classification algorithm is to build a model by processing existing data so that novel information can be extracted from the data. Moreover, model should be able to predict the output attribute given unseen input attribute values. The examples of classification algorithms are decision tree algorithms, rule-based algorithms, artificial neural networks, support vector machines and k-nearest neighbours [17]. In clustering or cluster analysis, data consist of only

the input attributes and no information of output attribute is present. The task of any clustering algorithm is to find natural groupings in the data, where each group must have maximum similarity among grouped data instances and maximum dissimilarity across different group instances [18]. Customer segmentation, anomaly detection and identifying association rules in buying patterns of customers are few examples of clustering algorithms [14].

At organisational level, identifying and managing the needs of various stakeholders are core to the success of organisations. The stakeholder can be divided into internal and external stakeholders. Customers, government and local council are few examples of external stakeholders. Employees and management are the examples of the internal stakeholders of an organisation. A significant research has been carried out to improve the relationship between organisation and external stakeholders using data mining algorithms. However, there is inadequate research on applying data mining techniques to improve the relationship between different facets of the organisation. Extensive research has taken place in the literature that establishes the importance of relationship between employees and organisational management and how this relationship is core to the success of an organisation [19, 20]. The researchers have used statistical analysis techniques such as correlation and regression analysis to establish and understand this relationship [1, 4, 21]. However, no efforts are made to extract useful information from such databases. The main objective of this paper is to use data mining algorithms to extract actionable and interesting patterns in the database (the impact of supervisors' leadership style on employees).

2. Literature review

In the 1940s, leadership was studied on the basis of the personal traits possessed by a leader such as physique, intelligence, cognitive ability, appearance, fluency of speech, knowledge, ambition, personal adjustment and emotional control. However, Bryman [22] argued that these traits solely cannot be recognised as factors of effective leadership, instead factors like situation, environment settings and the relationship with followers' matters in the role of effective leadership. Daft and Pirola-Merlo [1] have shown that a leader must have a variety of characteristics, namely personal characteristics, social characteristics and work-related characteristics. Personal characteristics deal with energy, physical stamina, intelligence, knowledge, judgement and decisiveness. Whereas, sociability, high interpersonal skills, cooperativeness and diplomacy are related to social characteristics. Work-related characteristics include stability in the face of hurdles, accountability in pursuing goals and mobility. A recent research conducted by Eid et al. [3] proposed that leadership must have two traits: basic traits and motivational traits. Basic traits cover emotional stability, dominance, enthusiasm, conscientiousness, social boldness, tough-mindedness, self-assurance and compulsiveness. On the other hand, leaders must possess traits which help them motivate their followers. These traits include high energy, intuitiveness, maturity, team orientation, empathy and charisma. Over the years, various leadership styles were proposed based on some combination of these characteristics and traits. In last few decades, the influence of these leadership styles on employees was thoroughly investigated. The success of every business is governed by its employees urge

to succeed through their efforts, commitment, engagement and practice. Therefore, it is the prime responsibility of leaders to motivate their subordinates with appropriate leadership styles and keep their aspirations high and achievable [23].

The effects of leadership styles (transformational and transactional) on different factors such as job performance, employee satisfaction and organisational commitment were studied in-depth by Norwawi [24]. The author revealed that leadership styles were vital to organisational development. The author also concluded that by using appropriate leadership style, job satisfaction, stress, employee turnover and productivity could be controlled effectively. Caillier [25] has found in his study that transformational leadership affects the performance of the employee with high mission valence. The clarity in goals resulted in higher levels of motivation in employees. Wang et al. [26] found in their study that transformational leadership has a positive effect on organisational justice and job characteristics. It is found that employees outperform the targets if leaders with transformational leadership can set the goal with clear communication and can motivate them [27]. Employees find self-respect and put additional efforts to achieve the goals if they are challenged and if the goals are set at high levels [28].

Similarly, transactional leaders have clear expectations that are communicated to their employees regarding goal attainment and the rewards upon fulfilment of their contractual responsibilities [27]. Attainment of the time bound task in an organisation depends upon the clarity of the goal and expectations conveyed to its employees, which helps them perform better. The use of contingent rewards inspires the employees explicitly or implicitly to exert extra effort for goal attainment. On the contrary, management-by-exception passive has a negative association with employees generating extra effort and also laissez faire leadership style relates negatively to job commitments. At certain times, a combination of transactional and transformational leadership is used by the leaders to increase motivation and productivity. This hybrid leadership style is becoming very popular in organisations [27].

Alloubani et al. [4] conducted a study in healthcare sector in Jordan and investigated the relationship between leadership styles (laissez faire, transactional and transformational) and employees' motivation, satisfaction and effectiveness. They evidenced that transformational and laissez faire leadership styles significantly affect employee outcomes (motivation to work hard, satisfaction and effectiveness); transformational style affects positively and laissez faire affects negatively all of the employee outcomes.

Leadership style also has impacts on organisational commitment and employee job performance [29]. They found an appropriate leadership style that enhances employees' problem-solving skills and helps employees to innovate. But, it is important to devise a right leadership style to match followers' characteristics [23]. They found that situational leadership style is more effective where leadership styles are tailored according to the situation and the followers' characteristics. Situational leadership exhibits multiple leadership styles and is more prevalent in contemporary organisations, encourages workforce diversity and brings optimal outcomes. The finding on the relationship between leadership styles and employee outcomes in existing literature is inconclusive in nature. This is one of the main reasons why data mining is most appropriate method to extract the trends and pattern out of this complex relationship between leadership styles and employees' outcomes.

3. Methodology

This study will investigate the impact of three leadership styles (*laissez faire*, transactional and transformational) on the willingness of employees to exert extra effort, effectiveness and satisfaction. In this study, the researchers have opted for a Multifactor Leadership Questionnaire (MLQ) for collecting data. MLQ is a popular instrument for the study of leadership styles [24]. MLQ is a proven instrument for measuring the leadership styles since its inception in 1985. The study has employed a five-point Likert scale questionnaire to collect quantitative data (where 1 being strongly disagree and 5 being strongly agree). The data were collected from the employees of small- to medium-sized enterprises (SMEs) in the Bay of Plenty Region of New Zealand. A total of 24 organisations were selected to gather data samples (within the range of 200–225) for this research. The participants answered questionnaires that portray the style of leadership of their immediate level manager. The goal of this research was to find and compare leadership styles of managers and their implications from the employee's point of view.

A total of 18 questions were designed to record the feedback on independent variables. Six questions each were designed to gather feedback on each leadership styles (transformational, transactional and *laissez faire*). The responses of these six questions were accumulated to find the score of each leadership style. Another nine questions were designed to gather responses of dependent variables. Three questions each for extra effort, effectiveness and satisfaction were designed, and the responses were calculated by taking the mean of each category questions. The pooled variable 'leadership outcome' was derived by taking the mean of extra effort, effectiveness and satisfaction.

There are number of data mining algorithms available in the literature such as artificial neural networks, support vector machines, decision trees, rule-based algorithms, k-nearest neighbours and Bayesian algorithms [17]. However, in this research, three algorithms, namely OneR, J48, and Modlem are used. These algorithms are used in this research as the outcome of these algorithms are in the form of a decision tree or a set of rules, which are easy to interpret.

OneR stands for One Rule or one level decision tree. This algorithm processes all input variables and selected single input variable that best model (classify) the output variable [30]. This is a very simple algorithm but has accuracy comparable to the state-of-the-art data mining algorithms. Mostly, OneR algorithm is used as a baseline algorithm against which the performance of other algorithms can be compared. Here, this algorithm will also be used as a baseline algorithm. The model accuracy and the degree of information extracted from the data will be compared to other data mining algorithms.

J48 or C4.5 is a decision tree-based classification algorithm proposed by Quinlin [31]. J48 builds the decision tree on the training data using the concept of information entropy. At each node, the algorithm selects a variable that split the data into defined classes with highest information gain. The variable with highest information gain is select to expand the node. Modlem algorithm generates rules based on rough set theory and more information can be found in [32].

In order to run data mining algorithms, the dependent variables' score will be transformed into categorical variables. The numeric scores recorded on the extra effort, satisfaction,

Labels/measure	Extra effort	Effectiveness	Satisfaction	Outcome
Low	57	33	42	33
Medium	102	102	94	94
High	43	67	66	75

Table 1. Frequency distribution of extra effort, effectiveness, satisfaction and (leadership) outcome after performing data transformation.

effectiveness and leadership outcome will be mapped to low, medium and high categorical values. The low category covers scores 1 to 3, medium between 3 and 4 and high from 4 to 5. The frequency table of all class labels are mentioned in **Table 1**.

4. Experimental results

A total of 210 samples were collected, of which three were discarded as these had missing values and another five were removed after conducting outlier analysis. The final 202 samples were used to analyse the data. The reliability test was carried out to demonstrate the internal consistency of various measures used in this research. Coefficient alpha or commonly known as Cronbach’s alpha was used to test the reliability of data, and the values of above 80% were obtained in all factors of this questionnaire.

4.1. Descriptive analysis

The total number of participants surveyed was 202 of which 66% were females and 34% were males. Approximately half of the participants (51%) were 25 to 34 years of age. The participants between the age 18–24 and 35–44 were 16% each. In terms of education, 36% of the participants had completed their bachelor’s degree. There were 26 and 24% of participants with diploma and postgraduate qualifications. The remaining 14% had their higher secondary school completed. Participant’s prior employment statistics showed that 44% of them had more than 7 years of total experience followed by 29% of them between 1 and 3 years of work experience. Participants with less than 1 year of experience and experience between 5 and 7 years were 7 and 8%, respectively. This depicts that the participants had fairly good experience of working in organisations. Working at the current job, more than half (52%) of the participants fall under the category of below 1 year of working at the current organisation, followed by 20% for 1–3 years of working at current job. Industries covered in this study ranges from health, hospitality, customer service, education and trades with health segment employing more females stood top at 34%, followed by hospitality at 25% and customer service 21%.

4.2. Correlation and regression analysis

Table 2 presents pairwise correlation coefficients and the statistical significance of each coefficient showing the relationships between leadership styles and employee outcomes. The

	1	2	3	4	5	6
1. Laissez-faire	1					
2. Transformational	0.11 (0.11)	1				
3. Transactional	0.30 (0.00)	0.46 (0.00)	1			
4. Extra efforts	0.11 (0.11)	0.71 (0.00)	0.37 (0.00)	1		
5. Effectiveness	-0.03 (0.70)	0.60 (0.00)	0.32 (0.00)	0.67 (0.00)	1	
6. Satisfaction	0.01 (0.86)	0.62 (0.00)	0.23 (0.00)	0.66 (0.00)	0.74 (0.00)	1

Significance levels in brackets under each coefficient.

Table 2. Pairwise correlation.

correlation coefficients suggest that transformational leadership has the largest score (0.71) on employee outcome of extra efforts and then on satisfaction (0.62) and on effectiveness (0.60). Higher scores in transformational leadership can lead to respectively higher employees' outcomes (extra effort, effectiveness and satisfaction). It is important to note that each of the correlation coefficients of transformational leadership with employee outcomes is statistically significant at 1% level. On the other hand, laissez-faire style has no statistically significant impacts on any of the employee outcomes. Interestingly, laissez-faire style reduces employee effectiveness. Transactional style has statistically significant impacts on employee outcomes; however, the correlation coefficients are much smaller in size compared to that of transformational. However, simple correlation coefficient is not a robust approach to predict such relationship because it is a simple two-way relationship and cannot control for all independent variables simultaneously and cannot control for other mediating factors that can potentially influence this relationship.

The multiple regression analysis is an appropriate approach better fit for such analysis. Multiple regression analysis was performed on the data, where the leadership outcome was regressed on leadership styles (transformational, laissez faire and transactional leadership) along with other mediating variables (e.g., participants' age, gender and total years of service). We also examined the relationship between specific leadership outcome (efforts, effectiveness, satisfaction) with leadership styles. The results are presented in **Table 3**. The multiple regression analysis between the leadership outcome and the leadership styles demonstrates that transformational leadership is the most effective style to bring most of the leadership outcomes.

More specifically, between the alternative choices of leadership styles, the coefficient estimates of multiple regression results suggest that, *ceteris paribus*, transformational style has the largest (0.14) and statistically significant impact (significant at 1% level) on leadership

	(Model 1)	(Model 2)	(Model 3)	(Model 4)
	Leadership outcome	Extra efforts	Effectiveness	Satisfaction
Laissez-faire style	-0.01 (0.01)	0.01 (0.03)	-0.08** (0.04)	-0.04 (0.04)
Transformational style	0.14*** (0.01)	0.48*** (0.04)	0.35*** (0.04)	0.46*** (0.04)
Transactional style	0.00 (0.01)	0.02 (0.05)	0.06 (0.05)	-0.07 (0.06)
Age	-0.08* (0.04)	-0.19 (0.16)	-0.17 (0.15)	-0.34* (0.19)
Gender	0.04 (0.07)	-0.15 (0.29)	0.35 (0.28)	0.22 (0.30)
Total service	0.01 (0.01)	-0.01 (0.06)	0.02 (0.05)	0.04 (0.06)
Constant	0.96*** (0.33)	0.51 (1.14)	4.28*** (1.28)	3.91*** (1.19)
Observations	202	202	202	202
R-squared	0.558	0.519	0.383	0.406

Robust standard errors in parentheses.

*p < 0.1.

**p < 0.05.

***p < 0.01.

Table 3. Multiple regression analysis.

outcome (Model 1 in **Table 3**). The largest R2 value (55.8) in Model 1 also suggests that the model can explain almost 60% variation of the leadership outcome. In regards to specific outcome, transformational significantly increases efforts, satisfaction and effectiveness (presented in Models 2, 3 and 4).

On the other hand, transactional style has no significant impact on leadership outcome or on any specific outcome, whereas laissez-faire style seems to reduce effectiveness. It implies that if leaders are keen to increase employee satisfaction and effectiveness and to motivate them to put their extra efforts, transformational style is the most effective. It is interesting to note that age is inversely related to leadership outcome and specifically to satisfaction; it might suggest that older people are more anxious if business environment is dynamic and changing and they feel less satisfied what inversely affect their outcome.

In summary, in Section 4.1, we have presented percentage analysis on the demographical variables, which helped us understand the distribution of surveyed data on the basis

of demographic variables (i.e. age gender, education level, etc.). In Section 4.2, multiple regression analysis along with Pearson correlation was performed to establish the significant relationships between leadership styles and outcome. These results demonstrated that transformational leadership style has statistically significant and positive impacts on extra effort, effectiveness and satisfaction and overall leadership outcome. In other words, in order to increase employees' productivity and organisational performance, managers should only pursue transformational leadership style.

4.3. Data mining

One Rule (OneR) is the first data mining algorithm used to analyse the data. This algorithm finds single best input attribute that split the data on the basis of output attribute (class label). The input variables used were leadership style scores (Laissez faire, transactional and transformational) and output variables were extra effort, effectiveness, satisfaction and leadership outcome (one at a time). The final rules generated on all four output variables (dependent variables) by OneR algorithm are stated in **Figure 1**. According to these results, the algorithm has found transformational leadership style the most influential in deciding the outcome of all four dependent variables. Moreover, these results strongly support the findings of the regression analysis carried out earlier in this research.

The rules generated by OneR algorithm are easy to interpret and understand. For example, the three rules obtained from the leadership styles (laissez faire, transactional and transformational—input data) and extra effort (output data) can be described as below:

1. If the transformational leadership score is less than 17.5, then employees will tend to exert low amount of extra effort.
2. If the transformational leadership score is greater or equal to 17.5 but below 25.5, then employees will tend to exert medium amount of extra effort.
3. If the transformational leadership score is greater than or equal to 25.5, then employees will tend to exert low amount of extra effort.

The accuracy of these set of rules was 66%, which means that of 202 data instances, 133 instances were classified correctly. The individual accuracy of all three rules is also provided in **Figure 1**, which can be read as correctly classified instances/total number of instances.

The accuracy values in the case of extra effort (**Figure 1**) can be read as: 66% of the information in the data can be extracted by following transformational leadership feature and three basic rules. Alternatively, it can be said that this model loses 34% of the information from the data.

J48 is the second data mining algorithm used in this research to extract actionable information. This algorithm builds a model in the form of a decision tree. The model built by this algorithm achieved an overall accuracy of 69% (140 correctly classified instances out of total 202 instances). In this experiment, three leadership styles were used as input data and leadership outcome variable was selected as a dependent variable. The final decision tree generated by J48 can be seen in **Figure 2**.

<p>Extra Effort (Model Accuracy 66%) If Transformational is less than 17.5 → Low (26/30) Else If Transformational is less than 25.5 → Medium (91/149) Else If Transformational is greater than or equal to 25.5 → High (16/23)</p>
<p>Effectiveness (Model Accuracy 63%) If Transformational is less than 16.5 → Low (14/23) Else If Transformational is less than 25.5 → Medium (93/156) Else If Transformational is greater than or equal to 25.5 → High (20/23)</p>
<p>Satisfaction (Model Accuracy 60%) If Transformational is less than 16.5 → Low (17/23) Else If Transformational is less than 21.5 → Medium (36/75) Else If Transformational is less than 22.5 → High(10/20) Else If Transformational is less than 25.5 → Medium (40/61) Else If Transformational is greater than or equal to 25.5 → High (19/23)</p>
<p>Leadership Outcome (Model Accuracy 64%) If Transformational is less than 16.5 → Low (17/23) Else If Transformational is less than 25.5 → Medium (90/156) Else If Transformational is greater than or equal to 25.5 → High (23/23)</p>

Figure 1. Rules extracted using OneR algorithm.

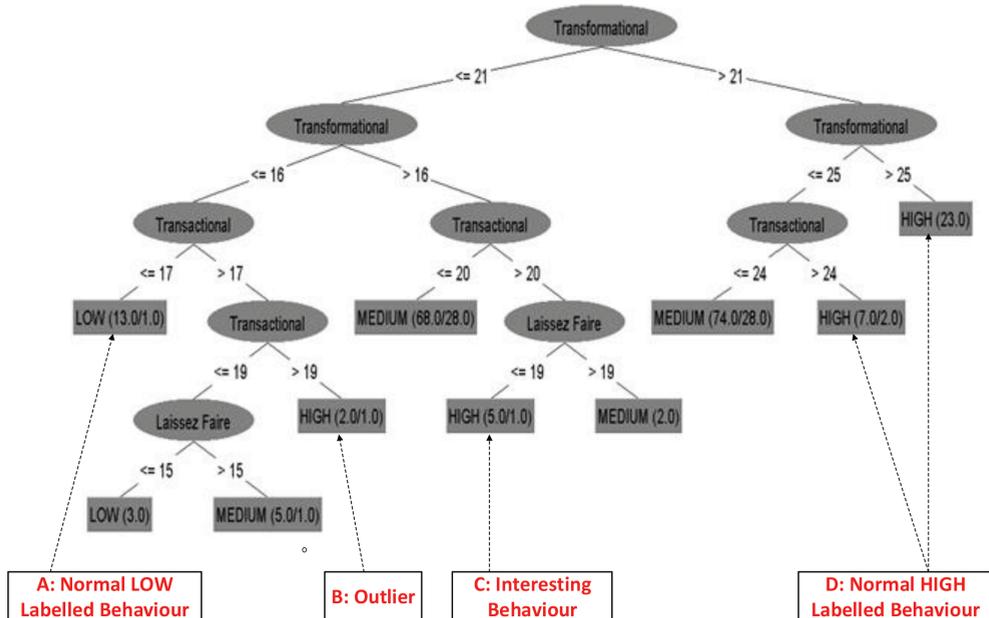


Figure 2. The model (decision tree) obtained using J48 algorithm with an accuracy of 69%.

The first split of the data is made at and above values of 21 on transformational leadership feature. This tree generates overall 10 decision trees using combination of all three features. Careful interpretation of the decision tree suggested that transformational and transactional leadership styles were playing main role in the construction of the tree. Total of 187 instances were classified using these two variables. The laissez faire style data were responsible for allocating class labels to 15 instances. The accuracy of this decision tree was 69%, which means there was 31% loss of information in this model (decision tree).

Overall, low outcome (class label) data are on the left hand side of the tree and the high outcome data are situated on the right hand side of the tree with medium mainly covering centre of the tree. This coverage is aligned with the results of OneR algorithm (stated in **Figure 1**). According to **Figure 2** (marker B: Outlier), the node with transformational value less than or equal to 16 and transactional values greater than 19 can be ignored or considered as an outlier. There are total two instances associated to this node out of which one is with high outcome and other with either low or medium outcome. The marker C in **Figure 2** has an interesting behaviour. This node suggests that a relatively low transformational value can achieve high outcome. According to this node, transformational values between 17 and 21 (both inclusive), transactional values greater than 20 and laissez faire less than equal to 19 can also produce high outcome. This information can be seen as an alternative solution of getting high outcome without increasing the transformational leadership skill value to above 25 (as suggested by OneR and this decision tree).

The final data mining algorithm used in this study was Modlem. The algorithm has generated total of 72 rules from the data (input variables as leadership styles and output variables as leadership outcome). However, few selected rules are shown in **Figure 3**. This algorithm has achieved an accuracy of 93% (184 correctly classified instances out of 202 total instances). For clarity, rules are separated based on their class labels (low, medium and high). These rules provide a great insight into the data. For example, rule 59 states that if a leader will have a transformational leadership style score less than 16.5 and laissez faire score below 14.5, then employees will have low outcome. However, rule 60 states that if leader's transformational style score is below 14.5 and laissez faire score less than 18.5, the employees will again have low outcome. The information deduction by reading rule 59 and 60 is that even though some leaders have relatively higher laissez faire score (14.5–18.5) at the cost of decreasing transformational score, their leadership outcome status did not change (stayed low). Another way these rules can be used is devising various pathway strategies for the managers (leaders) to move from one low outcome class to higher outcome class. For example, a leader belonging to rule 60 with low leadership outcome can be suggested to move from low to medium outcome class by either following rule 1 or rule 11. In order to move from low to medium outcome class, leader must improve his existing laissez faire score by 3 or 4 points. Alternatively, leader can improve his leadership outcome by keeping the laissez faire score same and only improving transformational leadership style score from 14.5 to 21.5 (minimum 7 points). Similar strategies can be adopted to move employees from medium to high outcome class by identifying a rule that someone belongs to and then finding a most suitable transition rule in the next outcome class label.

<p>Rules for Low</p> <p>Rule 59. (Transformational < 16.5) & (Laissez Faire < 14.5) → Low (7 instances)</p> <p>Rule 60. (Transformational < 14.5) & (Laissez Faire < 18.5) → Low (8 instances)</p> <p>Rule 61. (Transformational < 16.5) & (Transactional in [14.5, 17.5]) → Low (5 instances)</p> <p>Rule 62. (Transactional < 13.5) & (Laissez Faire >= 15.5) → Low (4 instances)</p> <p>Rule 63. (Transformational < 19.5) & (Laissez Faire in [12.5, 13.5]) → Low (5 instances)</p> <p>Rule 69. (Transformational < 18.5) & (Transactional < 16.5) & (Laissez Faire >= 16.5) → Low (5 instances)</p>
<p>Rules for Medium</p> <p>Rule 1. (Laissez Faire in [21.5, 22.5]) → Medium (5 instances)</p> <p>Rule 2. (Laissez Faire >= 18.5) & (Transformational < 20.5) & (Transactional in [13.5, 16.5]) → Medium (5 instances)</p> <p>Rule 5. (Transformational in [18.5, 20.5]) & (Transactional in [15.5, 16.5]) → Medium (7 instances)</p> <p>Rule 7. (Transformational in [19.5, 21.5]) & (Laissez Faire < 16.5) & (Transactional < 16.5) → Medium (6 instances)</p> <p>Rule 9. (Transformational in [20.5, 25.5]) & (Transactional in [19.5, 20.5]) & (Laissez Faire in [14.5, 19.5]) → Medium (8 instances)</p> <p>Rule 10. (Laissez Faire >= 18.5) & (Transactional in [20.5, 21.5]) & (Transformational >= 21.5) → Medium (6 instances)</p> <p>Rule 11. (Transformational in [21.5, 22.5]) & (Laissez Faire in [16.5, 23.5]) → Medium (6 instances)</p> <p>Rule 14. (Transactional in [17.5, 19.5]) & (Transformational in [21.5, 22.5]) → Medium (6 instances)</p>
<p>Rules for High</p> <p>Rule 34. (Transformational >= 25.5) → High (23 instances)</p> <p>Rule 35. (Transactional >= 25.5) → High (4 instances)</p> <p>Rule 36. (Laissez Faire >= 24.5) → High (5 instances)</p> <p>Rule 37. (Transactional in [21.5, 22.5]) & (Laissez Faire >= 12.5) → High (8 instances)</p> <p>Rule 38. (Transactional >= 24.5) & (Laissez Faire >= 16.5) → High (6 instances)</p> <p>Rule 41. (Transformational >= 24.5) & (Transactional < 18.5) → High (8 instances)</p> <p>Rule 47. (Laissez Faire < 12.5) & (Transformational >= 22.5) → High (6 instances)</p>

Figure 3. Modlem algorithm obtained an accuracy of 91% (only selected rules are shown here).

It can be seen from the rules and decision tree of OneR and J48 that in order to achieve high outcome transformational leadership value of 25 or above must be obtained. However, the rules extracted from Modlem algorithm in **Figure 3** suggest that a relatively lower value of transformation skills along with some specific values of transactional and laissez faire can also produce High outcome in employees (rules 35–38). Similar rules can be extracted for low and medium outcomes.

In these set of experiments, three data mining algorithms, namely OneR, J48, and Modlem, were used to analyse the data. The experiments demonstrated that these algorithms can be used to better understand the data and how segments of the input data are associated with the output variable. The information extracted from these algorithms (decision tree or rules) can be used to devise better informed management strategies to improve organisational performance. The results obtained from our data mining algorithms support the claim of existing literature that transformational leadership style is most effective in organisations due to the fact that it inspires employees to perform better, increase employees' engagement and create a healthy environment where future business leaders can be nurtured [2].

5. Conclusion

This paper investigated the impact of various leadership styles (transactional, transformational and laissez faire leadership styles) on leadership outcome. The leadership outcome was measured using extra effort, effectiveness and satisfaction. A number of statistical and data mining methods were used. The statistical methods included were correlation and regression analysis, whereas rule-based and decision tree algorithms were part of data mining algorithms used to extract interesting information from the data. Multiple regression analysis of independent variables (leadership styles) and dependent variables (extra effort, effectiveness and satisfaction) was carried out. The results indicated that transformation leadership style had a significant relationship with all three dependent variables. Moreover, the regression analysis of leadership outcome (aggregation of extra effort, satisfaction and effectiveness) and three leadership styles were carried out, and experimental results reiterated that transformational leadership style had a significant relationship with leadership outcome.

The data mining algorithms (rule-based and decision tree algorithms) were used to extract actionable information from the surveyed data. The values of dependent variables (extra effort, effectiveness and satisfaction) were transformed from numeric to nominal (low, medium and high). The single feature-based rules generated by OneR algorithm suggested that transformational leadership style is the most important variable to split dependent class variables. The final obtained models had accuracy of 66, 63 and 60% on extra effort, effectiveness and satisfaction, respectively. The rules extracted from this algorithm can be used to devise various management policies to enhance supervisors' leadership outcomes (extra effort, effectiveness and satisfaction). Another algorithm used in this thesis to analyse surveyed data was Modlem. This algorithm produced total 72 rules with 91% accuracy. These rules can be used to assist management to make rationale and more informed decisions. Lastly, J48, a decision tree-based algorithm, was used to construct decision tree. The main contribution of this research is that we have used data mining techniques to extract hidden and interesting patterns in the data in the form of understandable rules and decision trees.

Input, process, output and feedback are four main components of a standard business information system (**Figure 4**). In the context of this research, inputs were the data used (including independent and dependent variables) and processes were statistical and data mining

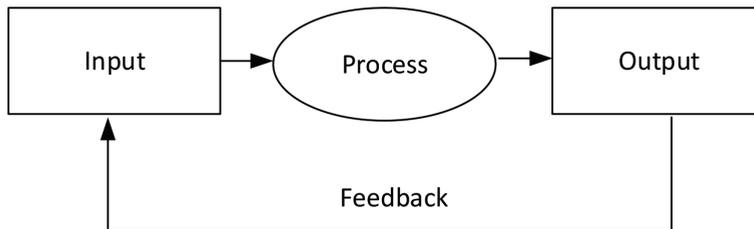


Figure 4. Components of the business information systems.

algorithms applied on the data (correlation, regression, OneR, J48 and Modlem). The outputs were correlation, regression and decision trees obtained using data mining algorithms. The feedback consisted of the information extracted from the regression analysis and various rules extracted from the data mining algorithms. Management can use direct and actionable output from various processes to direct their various internal stakeholders. In the light of this feedback, internal stakeholders can improve their productivity and performance.

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