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Collaborative Surgical Team Formation: A Proposed Theoretical Framework Using Genetic Algorithm

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ABSTRACT

The imbalance in surgical team composition has a significant impact on the increment of surgical failure and error. The crucial factors influencing the optimal surgical team members are experience, skills, trust, and leadership. Hence, this study aims to maximize surgical team formation effectiveness with a systematic and data-driven approach to team composition for minimizing human error, maximizing safety, and promoting active communication and reliability among team members that can result in successful surgeries. A theoretical framework has been proposed for optimizing surgical team formation using a Genetic Algorithm (GA). This proposed framework is predicted to assemble an effective collaborative surgical team that can perform a successful surgery based on the multi-objective function: the performance indicators and social-based ratings.

Keywords:
collaborative team; surgical team; theoretical framework; optimization; genetic algorithm

1. Introduction

The healthcare industry is experiencing rapid growth due to the emergence of several medical service trends that are significantly shaping and influencing the future of physical wellness [1,2]. Amidst this evolving transformation, one of the critical aspects that is crucial and demands attention is the formation and composition of surgical teams. There is a lot of extensive research in healthcare that encompasses various advancements and modifications, including biomedical and clinical care, health system and management, mental and emotional well-being, ethics and social aspects, healthy lifestyle and behavior, and aging and in-needs populations. Hence, healthcare research is a dynamic and broad field that covers vast areas that collectively contribute to the advancement of medical knowledge, improvement in patient outcomes, and molding the healthcare policies and practices.

Furthermore, the increasing aging population and the rising occurrence of chronic illnesses such as diabetes, cancer, stroke, and heart disease all around the world demand long-term care and the growing need for breakthroughs in medical procedures, management, and treatment. In Malaysia, the government has made significant investments in the healthcare industry by targeting to spend 5% of GDP on the healthcare sector by 2025. This strategic investment aims to expand access to

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better and higher-quality healthcare, reduce the burden of chronic diseases, and ultimately enhance the population's overall health.

Concurrently, the rise of digital health in Malaysia has shown stable growth, especially in the fields of telemedicine, electronic health records (EHRs), and other innovative medical technologies that are able to transform the healthcare delivery approach and hold enormous potential in the improvement of risk management, preventive care, and patient-centered care and satisfaction. For instance, telemedicine is a valuable option and solution that enables patients to receive medical attention from a doctor or other healthcare practitioner remotely. Therefore, improving healthcare access for individuals in rural areas or who have difficulty traveling to medical centers [3]. EHRs enable healthcare providers to access patient medical information easily and efficiently from anywhere, significantly improving patient treatment coordination and reducing the risk of medical errors.

Despite being complex and challenging, the advancements in the medical field remain in high demand due to their important role and are essential in improving human health. In recent decades, significant advancements and breakthroughs in clinical and experimental research have led to significant improvement in the development of a variety of vaccines and drugs, a wide range of disease treatments, and the discovery of diagnostic tools, surgical techniques, and procedures. These transformations in the medical field can help extend the lifespan and improve the quality of life of millions of people worldwide.

The field of surgical techniques and procedures has advanced tremendously in recent years, which has led to significant improvement in surgical outcomes for patients [4]. These improvements include enhancing patient safety, optimal resource utilization, higher surgical success rate, and effective problem solving that can lead to significant patient advantages for faster recovery times, more effective pain management, and a reduced risk of complications. A significant contribution towards the improvements is the optimal formation of highly skilled professional surgical teams [4-15]. The critical components of the collaborative surgical team formation consist of surgeons, anesthesiologists, nurses and operating room staff, surgical technologists, specialists, preoperative and postoperative teams, and other healthcare professionals who work together seamlessly to provide top-notch care.

The surgeons are the key players in a surgical team in carrying out the vital part of the surgical operation and significantly impact the surgical outcomes based on their expertise, experience, and judgments. The anesthesiologists play a vital role in the surgical operation by administering anesthesia and monitoring the patient’s vital signs to ensure safety and stability throughout the surgical process. Nurses play various roles in the operating room by assisting with preparing the patients, maintaining the sterile condition in the operating room, and ensuring the necessary supplies for the medical team. Surgical technologists support the surgical operation by preparing the room to ensure the surgical instruments are fully sterile and arranged and supporting the surgeons during surgical procedures by keeping track of the surgical materials. Specialists are the experts consulted and directly involved in surgical procedures by providing specialized knowledge and diagnostics. Preoperative and postoperative teams are responsible for coordinating the patients’ preparation for pre-surgery and optimizing patients’ recovery post-surgery. Based on the diverse and various demanding responsibilities in the surgical team composition, it is crucial to ensure the team consists of experts who are able to collaborate effectively to ensure the success of a surgical operation.

The demand for such collaborative surgical teams has increased due to their ability to improve surgery time management, increased specialization, and the development of new technology-aided skills. This advancement is much needed as the operating room is a complex environment requiring high coordination and teamwork. The environment consists of multi-layered social interaction and

activities with unpredictable situations and a low tolerance for mistakes [5]. The critical aspects that must-have for a collaborative surgical team's formation involve excellent communication, experience, interdisciplinary cooperation, team training and education, preoperative planning, emergency preparedness, and continuous monitoring and improving skills. Hence, many aspects need to be considered as the parameters for forming a perfect team. Therefore, an optimization approach is necessary for evolving the parameter selections and measurement towards a better solution. Therefore, to be able to produce an efficient medical team for surgery within a short period, a theoretical framework of collaborative surgical team formation using Genetic Algorithm (GA) was proposed. Each team member has a set of properties that can be altered for better selection and gradually enhanced with the iterative process for optimal formation. As well as the challenges of surgical team formation, key elements of collaborative surgical team formation and concluding remarks are added to this paper.

2. Challenges of Surgical Team Formation

In the surgery field, the formation of an effective surgical team is a critical factor in achieving success in surgical procedures as it requires high-cost resources, including staff, equipment, and medicine. The team members of surgical teams are usually related to the operating room (OR) planning and scheduling, which involves many participants and resources such as the OR managers, surgeons, patients, and equipment. Unlike other sectors in healthcare, for instance, previous studies by Rosli *et al.,* [6] that utilized only the hemodynamic parameters to identify the formation of coronary artery disease and its effect on the physiological blood flow. This shows that the factor considered was not as complex as it seems. Compared to other teams in other sectors, the surgical team faces a higher level of stress in the OR. Thus, apart from only considering availability and resource allocation, the formation process can be complex as it also requires the team members' high surgical skills and experience, as well as the ability to work in a team effectively. This formation is important as the perioperative team familiarity of each team member facilitates a smoother and less complicated operation [7]. To address this challenge, an optimization method is needed to help ensure the formation of effective surgical teams.

Many solution approaches have been introduced in exploiting the technology for solving the surgical team formation problem. The development of healthcare solutions in Artificial Intelligence (AI) has taken place tremendously. In recent years, digital data has been generated at an unprecedented rate, promoting tremendous progress and breakthroughs in transforming human capability and intelligence into technology systems and automation. Other sectors such as studies done by Ahmad *et al.,* [8] that applied the particle swarm optimization to estimate the potential evapotranspiration in engineering fields show the potential of utilization AI. Meanwhile, the bio-inspired algorithm has become one of the optimization techniques that have been widely exploited for aiding the medical data process and improving the medical predictions and measurements in surgical team formation. For instance, a study proposed a framework based on an efficient clustering algorithm for mixed data to identify optimal subgroups of patients, which will be utilized by a multi-objective optimization algorithm (MOOA) for selecting optimal surgical teams [9].

Similar considerations were also developed by other studies but by proposing a meta-heuristic framework for objective evaluation of surgical teams and finding the optimal team for a given patient, in terms of the number of complications [10]. Another study developed two meta-heuristics (Non-dominated Sorting Genetic Algorithm, NGSGA-II, and Multi-Objective Particle Swarm Optimization, MOPSO) to find Pareto solutions of providing more realistic and effective solutions for the problem by considering several practical factors [11].

The surgical team formation has received a lot of interest in the research field, with several researchers having conducted many reviews and analyses for this problem. Different approaches have different pros and cons. Analysis showed that many researchers had focused on simulation optimization and metaheuristic methods for solving OR problems [12]. This is due to the ability of some metaheuristic approaches to find a set of well-converged and diversified non-dominated solutions, called Pareto solutions, that perform better in a single iteration for the multi-objective optimization problems (MOOPs).

Additionally, some metaheuristics are suitable for solving global optimization problems, including non-convex and discontinuous problems. However, metaheuristic is based on random evolution and it is difficult to prove their convergence as it is based on approximations and is usually non-deterministic. A similar review was conducted by previous studies [13], indicating that the metaheuristics approach is widely chosen for optimization problems as it can find feasible solutions with less computational effort than optimization algorithms, iterative methods, or simple heuristics.

Recent research has shown that a well-coordinated surgical team can significantly enhance communication and management between team members and management via focusing on surgery scheduling, workflow tracking, and patient flow [14]. The improvement can lead to a lot of benefits, including improved patient safety, reduced hospital stays, and reduced medical costs. However, based on the previous finding in the study [15], there are other significant challenges to surgical formation teams. These include team members' availability, skill levels, experience, trust levels, and leadership capabilities.

Generally, the formation of a surgical team is based on an open scheduling strategy which is dependent on the type of patient (outpatient or inpatient), resources (such as surgical equipment and operating room) allocation, and medical personnel availability, with the primary goal to accommodate as many surgical cases as possible without considering the familiarity of the surgical team dedicated [16]. These findings provide valuable insights into the potential benefits of integrating human-based and social-based factors into forming a collaborative surgical team. However, further study is needed to address several limitations and extend our understanding in this area. As mentioned earlier, it is crucial to have an optimal surgical team that can effectively work with each other to have better coordination and deliver the best to have a positive outcome for the surgery. Thus, the selection of the surgical team member must be carefully decided with the relevant factors that can contribute to optimizing the patient’s outcome.

A recent study [5] found that the formation of a surgical team has a significant impact on patient outcomes. The study highlights that well-balanced and skilled teams are more likely to achieve treatment effectiveness, patient safety, and satisfaction. This treatment effectiveness is closely linked to the success rate of surgical procedures. Another similar study also depicted that greater team familiarity of each team member facilitates a smoother and less complicated operation [9], which strongly support that optimization of the OR by increasing familiarity among team member leads to the potential improvement in patient outcomes as well as in terms of cost-benefits to the healthcare sectors. Successful surgery can boost the medical staff's motivation, knowledge, and skill upgrade. This can improve mental health and well-being for both patients and medical staff.

The previous study by [10] indicated that efficiency and fully organized team members can increase patient positivity, reliability, and trust in the hospital's patient healthcare. Another similar research on surgical team formation by considering surgeons’ preferences and cooperative operations resulted in successfully addressing the issues of cooperative operation, which encouraged surgeon satisfaction and patient outcomes [17]. Patients will feel comfortable and confident with healthcare when they observe an efficient and organized team.

Other than that, a study also showed that the work climate within the operating room can significantly impact the interpersonal relations between the surgery team members. A positive working environment can foster trust and cooperation between team members, ultimately leading to improved team performance [18]. The efficiency of surgical team planning can increase surgical team quality, performance, and success rate. Efficient planning can ensure the formation of the right team members is highly available with the right skills and experience [5]. This can help to reduce the risk of complications. A study has highlighted the importance of teamwork and communication among surgical team members to ensure that the surgical team operates smoothly and efficiently [19]. All of the studies reviewed provide valuable insights into the potential effects of having an excellent collaborative surgical team and show the significant impact of prioritizing team formation to ensure that patients receive the highest quality of care and reduce the risk of errors in the OR. However, the question of how the formation of the collaborative surgical team can be formed with the implementation of optimization methods remains unanswered, highlighting the need for further research.

3. Key Elements of Collaborative Surgical Team

In the context of surgical team formation, a multi-objective function could be used to maximize several factors. Based on the review conducted, a compilation of features and team formation factors are summarized in Table 1.

Table 1
Compilation of features and team formation factors

References	Domain	Factors
[11]	Incorporate the decision-making styles of the surgical team members in an operating room scheduling problem.	i. Priorities of patient ii. Resources availability iii. Staff availability iv. Skills v. Experiences
[17]	Team familiarity in surgical team performance.	i. Teamwork ii. Collaboration iii. Experience
[18]	Effective surgical team.	i. Teamwork ii. Communication iii. Trust iv. Hierarchical v. Skills
[19]	Knowledge-based system for collaborative surgical team.	i. Availability ii. Trust iii. Skills iv. Leadership
[20]	Barriers and enablers to effective interprofessional teamwork in OR.	i. Familiarity ii. Availability iii. Communication iv. Leadership v. Teamwork

Based on Table 1, the factors that can be highlighted are the skills, experience of the surgical team, teamwork, and communication skills of the surgical team. By taking all these surgical team formation aspects into account, the team can be better equipped to overcome any challenges that may arise during the surgical procedure and able to ensure the best possible outcome for the patient.

Similarly, a study has identified similar factors as the challenges in forming an effective collaborative surgical team [1]. These challenges include the medical staff's performance indicator and social-based factors that can lead to effective communication, a high level of trust, and committed collaboration and teamwork. Hence, integrating the aforementioned factors as the multi-objective function for forming a surgical team could result in better work coordination between team members and there will be higher chances of achieving optimal outcomes for patients.

3.1 Performance Indicators

Previous research has shown that the performance of a surgical team is closely linked to the level of experience and skill possessed by each team member [14]. In surgery, the area of expertise and experience of health practitioners handling the surgery is important. Even though an individual possesses good personal skills, it is meaningless to have a member with no supporting track record of being able to collaborate effectively, especially when it comes to critical conditions that urge all members to work together [21]. In addition, a study by [22] has highlighted that experience and skills can be highly valued and contribute significantly to the accuracy of the results based on the last five years of the professional assessment.

3.1.1 Experience indicator

According to the study conducted [23], the concept of experience can be identified and interpreted as familiarity and repetition of the surgical team members in handling surgical procedures. The repetition indicates the number of procedures that the team participated in. Based on the findings by previous studies [15, 22, 23], it can be concluded that a minimum of five years of experience can be a reliable indicator for assessing the overall value of the surgical team's performance.

The medical staff experience assessment can be evaluated by considering the total number of procedures that each individual has been practicing over five years. The use of experience as a performance indicator is to determine the objective measure of experience by considering the possibility that some medical staff may have more experience than others despite practicing for the same amount of time. By using this indicator, the experience can be comprehensively measured.

3.1.2 Skills indicator

Skills can be identified as the number of successful surgeries that have been achieved based on the total number of procedures that the team members have participated in [24]. Recent research [24] has identified that quality tools, training, and simulation generate work standardization and improved teamwork as well as individual skills. Team members with low skill and training lack of surgical awareness are usually associated with a surgical technical error. This can lead to a decline in technical performance and a slight increase in surgical complications. Based on the findings by previous studies [15, 24, 25], the five years of successful surgical achievements can be used as the skill indicator to value the team's performance. The use of skill as a performance indicator has an advantage as it considers that some team members may have more skill than others, even if they have performed the same number of surgeries in the last five years.

3.2 Social-Based Factors

Social-based factors involve individual perceptions that symbolize the subjective indicator and are hard to calculate by an exact score [15]. By taking into account these social factors, it is possible to create a more supportive and collaborative environment for surgical teams. The key factors that contribute to a successful surgical team based on social factors are depicted in Table 2.

Table 2
Key factors based on social factors

Factors	Description
Communication	The capability of the team members to communicate effectively with each other both verbally and nonverbally. This includes clearly conveying instructions, asking questions, and giving feedback.
Trust	The team members must trust each other's skills and abilities. This trust is essential for creating a safe and supportive environment in which to operate.
Collaboration	The team members must cooperate in working towards a common goal. This requires the willingness to compromise and a commitment to the team's success.

3.2.1 Trust factor

Previous research [18] has shown that subjective performance based on social impacts, such as communication and trust, can be evaluated by self-evaluation and other team members' evaluation. The trust factors approach is based on the following assumptions:

i. Team members can accurately self-evaluate their own communication and trust skills.
ii. Team members can accurately evaluate their fellow team members' communication and trust skills.
iii. The average mean of self-evaluation and other evaluations is a good indicator of the level of trust between team members.

3.2.2 Communication factor

Excellent communication among the personnel care in the team leads to the trust of individuals in each other, and task coordination can be performed well so that work will not be redundant and everyone understands their roles in the task [26]. Another studies [20] has identified communication practices or strategies as the perceived enabler to effective interprofessional teamwork in the operating room that leads to the trust of the team members to effectively communicate among each other for better teamwork and work coordination during operation. Hence, in the operating room, there will be a position that acts as the leader, and some members will act as the order follower.

An effective team will improve the quality-of-care patients receive. Previous findings [27] indicated that the effectiveness of a team is hugely influenced by the way it is led. Although there is no one style deemed as ideal for leadership, a surgical team led by a non-threatening, engaging leadership style produces more impact, especially by creating a safe climate where team members can voice their opinions and concerns. A strong leader is essential for communicating and coordinating the members to ensure everyone in the team is working towards the same goal and understanding.

Leadership is particularly involved with the surgeons who are responsible for the patient's overall care and the surgical team's coordination [28]. The communication factors are based on the following assumptions:

i. Surgeons can accurately self-evaluate their leadership skills.
ii. Surgeons can accurately evaluate the leadership skills of their fellow team members.
iii. The average mean of self-evaluation, lead procedures, and other evaluations indicates the surgeon's leadership level.

4. Optimizing The Surgical Team With GA: Theoretical Framework

The optimization approach for surgical team formation is a promising area of research. As AI continues to develop, optimization methods have become more sophisticated and effective. Hence, it could significantly improve patient treatment efficiency. In the context of surgical team formation, multi-objective functions must be included for forming an optimal surgical team, such as the experience indicator, skills indicator, trust factor, and communication factor that would be representative of a population of a set of surgical team candidates.

Figure 1 displays the framework of the collaborative surgical team formation. Initially, a request for a group formation will be defined by the constraint of the type of surgery, the factors of the individual, such as skill and experience, and the number of personnel needed for that surgery. Based on the current data, the genetic algorithm will develop a better new generation of surgical team based on the current population. Then, the system will display the proposed group formation. Upon approval of the personnel involved, if all the personnel involved in the proposed group accept, then the group is formed. Else, if any of the personnel decline, regrouping is required.

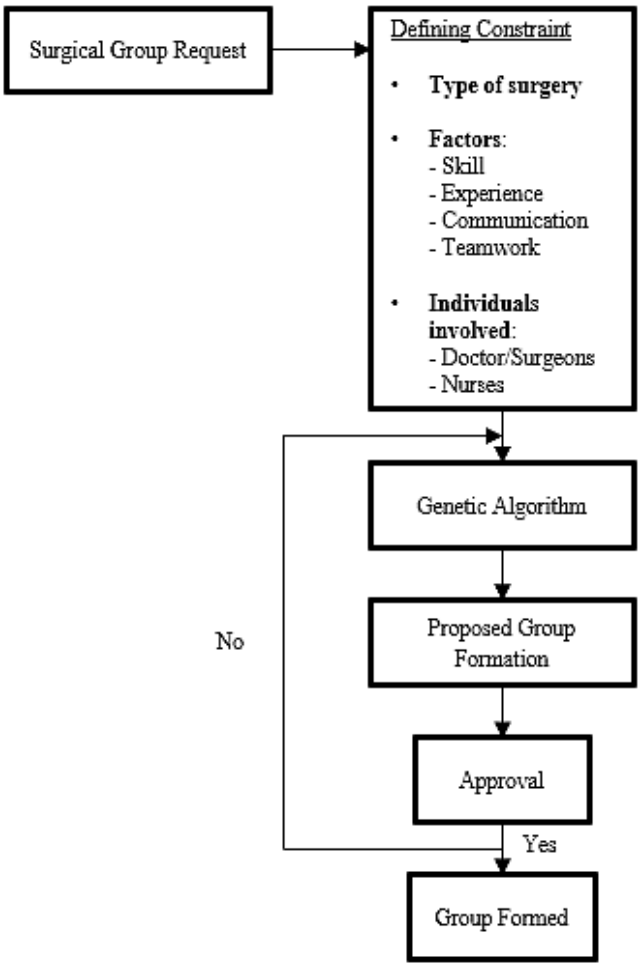

Fig. 1. Framework of the collaborative surgical team formation

Multi-objective optimization is a mathematical technique that can solve problems with multiple conflicting objectives. For this phase, the initial work will be about formulating the objective function for the surgical team formation. Multi-objective functions will be formulated since they must deal with the flexible range of factors obtained in the previous phase. The overall main objective function will be comprised of sub-objective functions based on the factors clarified at every team formation. The essential factors for the task will be defined for every team formation request. The number of individuals required for any task is defined based on categories of medical personnel. Figure 2 displays the formation of a team to complete a given surgical task.

Surgery task, t = $\{p_1, p_2 \dots p_n\}$, with *n* number of *p* factors.

Medical personnel, *A* = $\{p_1, p_2 \dots p_n\}$,

Team, $C = \sum_{k=1}^{s} g_k(A_{1\{p_1,p_2\dots p_n\}}, A_{2\{p_1,p_2\dots p_n\}}, \dots, A_{m\{p_1,p_2\dots p_n\}})$

Fig. 2. The representation of team formation

Based on Figure 2, the surgery task, *t*, will be identified based on the type of surgery of a particular health issue that requires *p* number of factors to ensure the success of the surgical process. The medical personnel, *A*, will be identified based on the surgery task, *t*, as the factors will be the parameters to value the medical personnel performance indicators and social-based ratings. The formation of the surgical team dataset, *C*, will consist of a set of surgical teams, *s*, with each team g_k, having a number of medical personnel, *m*, with each of the medical personnel, *A*, consisting of parameter data that represent the value of each of the team members.

The success of the enhanced genetic algorithm is dependable on the formulation of the multi-objective functions for the algorithm to measure the quality of the solution in a cluster and the scheduling techniques. As the measure proposed for the clustering criteria, the multi-objective function for the team formation is optimal in terms of being in equilibrium. The multi-objective function value will be utilized by the genetic algorithm in quantifying the solution and optimizing the solution to find better surgical team formation.

After the multi-objective function has been formulated, the fundamental aspect of this research is the development of the Genetic Algorithm (GA). This research has utilized a bio-inspired algorithm, the GA, to optimize surgical team members' selection based on performance indicators and social-based factors. GA is a metaheuristic algorithm inspired by the natural selection process. It works by iteratively searching a population of possible solutions and selecting the solutions that give the higher fitness value where the fittest individuals will have a high chance of reproducing and being able to pass on their genes to the next generation, called offspring as stated by previous research [25, 29-31]. This algorithm can solve various problems, including optimization and search problems [32]. GA can be used to select team members with the necessary skills and experience who are likely to work well together. GA can also be used to consider social-based factors, such as teamwork and communication, which can significantly impact patient outcomes.

In a review by Isa *et al.,* [33], the adaptability of GA in finding suitable solutions to problems by facilitating the discovery of optimal or near-optimal solution within large solution spaces, displayed the capabilities of GA over the traditional methods and approaches. GA is an evolutionary algorithm that can solve optimization problems where the fittest individuals are more likely to survive and reproduce. GA works by iteratively creating a population of chromosomes, each representing a

possible solution to the problem. The chromosomes are then evaluated using a fitness function, which measures how well they solve the problem. The fittest chromosomes are then selected to create the next generation of chromosomes. This process is repeated until a satisfactory solution is found. Figure 3 shows the basic framework of GA.

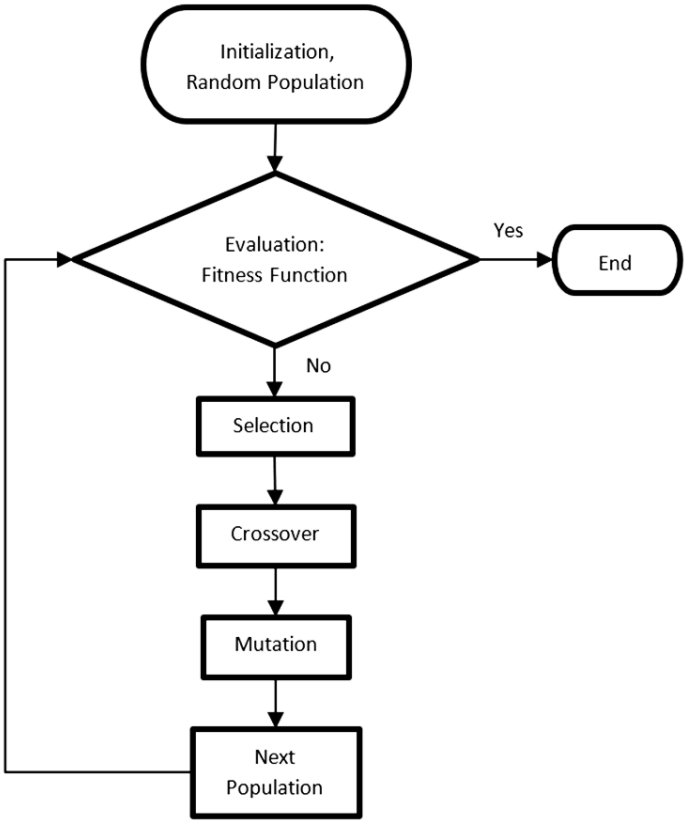

Fig. 3. Fundamental genetic evolution process under GA

Based on Figure 3, the first step of GA is to initialize the population and the cycle iterations. In this study, the population was proposed to be generated randomly for each surgical team. Each team would have a set of chromosomes representing a possible combination of team members. A chromosome is a string of genes that can be suited to the data type that becomes the optimization vectors based on the encoding types. The score of each allele of the chromosome is based on the features of the collaborative surgical team as the objective functions that have been discussed before, and the overall individual score of the surgical team will be determined as the fitness value of the individual chromosome.

The chromosome is represented, which, in this case, is created based on the input constraint for the particular surgery. For instance, if a particular surgery requires a team of 2 doctors and three nurses, then five genes will be assigned with value one, denoted as being in the group. Otherwise, the value 0 indicates that the gene will not be in the group. A counter based on the category of the members is introduced to control the constraint set for distinct categories of team members, such as doctors and nurses.

Figure 4 illustrates the example of the chromosome representation. In this representation, gene-0 to gene-3 is assumed to be in the doctor category, and the remaining gene is in the nurse category. After the initial random population, these parents' chromosomes will generate the new generation. Based on Figure 2, the first operator is the selection operator. The selection operator chooses the fittest chromosomes to create the next generation. There are many selection operators, such as

roulette wheel and tournament selection. Two parents of the population set of chromosomes will be selected based on the selection operator for generating the new offspring. The selection approach is necessary to find the highest score of the chromosomes to represent the fittest values. The value of the fitness function will be formulated as mentioned before by the multi-objective function.

0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	i_{th} *gene*
1	0	1	0	1	0	1	0	1	0	*allele*

Fig. 4. Example of chromosome representation

The crossover operator combines two chromosomes to create a new chromosome. The new chromosome will introduce new genetic information into the population and improve the chances of finding a better solution. For crossover operation, the order-1 crossover will be adapted because of its simple permutation. A crossover point will be set on the alleles before proceeding with the crossover and will also be used to separate the crossover point of the two categories for group members. The proposed use of a crossover points to organize the categories will be tested in this research. This is a crucial process to ensure the elements' permutations and the number of members within the category remain the same after the crossover occurs.

The new generations will be mutated based on the mutation operation. The mutation operator randomly changes a chromosome. This can help prevent the population from becoming constant and help find new solutions. The mutation also will be done based on the unique identity limitation. Hence, the mutation can only occur between the existing values of encoding in each of the alleles to represent each team member. The new fitness values of each new generation will be determined based on the summation of the objective functions of this study. The newly generated fitness values from the new generations will be compared with each of the current population's members in the current iteration of GA. If the new generations (offspring) have shown better fitness value compared to the current population members, the offspring will replace the current member of the population. The iteration of this algorithm will stop when the given condition of the iteration becomes false.

5. Conclusions

The healthcare industry is undeniably dealing with various challenges, including the rising cost of healthcare, the shortage of healthcare workers, and the gradually growing complexity of medical treatments. However, the industry is also making significant progress in overcoming these challenges with great success. Through unwavering investments and innovations, the healthcare sector is well-positioned to continue improving the health and well-being of people worldwide. This proposed theoretical framework leveraging Genetic Algorithms (GA) for collaborative surgical team formation is the approach able to address the crucial issue of surgical team balance. By manipulating the fitness function of assembling an effective collaborative surgical team based on performance indicators and social-based ratings as the objective functions, it is expected that this approach is able to predict the success of surgical operations. In conclusion:

i. Imbalance in surgical teams can be the vital factor that leads to an elevated risk of surgical failures and errors. The probability of negative results and failures significantly rises when the surgical team lacks unity and experiences disparities and inefficient skill sets.
ii. The primary objective of this study is to maximize the effectiveness of surgical teams by optimizing the selection of team members. The achievement of surgical operation depends

on the precise optimization of the team member selection process by considering factors such as skills, experience, trust, communication, and leadership abilities.

iii. The study proposes a framework for optimizing surgical team formation. This systematic and data-driven optimization approach has leveraged Genetic Algorithms (GA) to navigate the complex of collaborative development teams for achieving team dynamics and composition. This proposed framework is theoretically able to form an efficient and well-balanced surgical team.

iv. The proposed theoretical framework is expected to be able to predict the success of surgical procedures.

This study emphasizes the crucial challenges in forming surgical teams to ensure the security and effectiveness of surgical procedures. The GA-based framework has been proposed to redefine the surgical collaboration team formation as a well-established theoretical framework. This framework will act as the guiding principle that exploits the predictive insights to advance the healthcare industry towards greater levels of excellence and patient-centered care.

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